

NC
750
.T48

PHILOSOPHICAL
PERSPECTIVE



Digitized by the Internet Archive
in 2016

NC
750
1748

PRACTICAL PERSPECTIVE,

FOR THE USE

OF

STUDENTS.

TRANSLATED FROM THE FRENCH OF

T. P. THÉNOT,

BY ONE OF HIS PUPILS.

NEW YORK:

WILLIAM JACKSON, 102 BROADWAY.

MDCCCXXXVIII.

1838

COPYRIGHT SECURED.

HAROLD B. LEE LIBRARY
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH

P R E F A C E .

THE principles of Perspective require for their demonstration a degree of mathematical knowledge, which, if not of a very high order, is often beyond the reach of those who wish to apply them to practical purposes. On the other hand, the useful rules derived from these principles, are sufficiently simple and intelligible to those unacquainted with Geometric Science; and Perspective, unlike any other branch of mathematics, does not require as an evidence of the truth of its problems, a direct recurrence to the investigations on which they are founded. If the painter could never have attained the rules which are to serve as guides for his practice, without the aid of the Geometer, his own eye is sufficient to satisfy him of their accuracy.

The only complete works on Perspective which have hitherto appeared are principally devoted to the mathematical theory, a theory useless to the artist; for he can rarely appreciate its accuracy and does not need it for his conviction. Those manuals of practical rules which have been compiled, are meagre in their details, and are far from furnishing the great variety of cases and instances which are necessary in the practice of the pictorial art. One which should omit the mathematical investigations, and should at the same time furnish all the rules that the most extensive practice can require, has, therefore, hitherto been a desideratum.

This want, we conceive, has been fully supplied by the work, of which a translation is now offered to the public. The translator has been induced to undertake the task from having personally experienced, as a pupil of the author, the value of the method he pursues; and it is presented in full confidence that the work will be found of no small utility to both the professional man and the amateur; while to those most conversant with the mathematical principles of perspective, it will furnish a convenient manual of reference.

New-York, June 25th, 1834.

PRACTICAL PERSPECTIVE.

It is indispensable to acquire a knowledge of the rudiments of Perspective, if a student of drawing wishes to obtain correctness in the art. There are a few simple rules founded upon mathematical principles, and every line not drawn according to those rules will be incorrect.

It is not absolutely necessary that the pupil should be a thorough geometrician before he can study Perspective, but the following definitions must be well understood.

OF THE POINT.

Plate I. Fig. 1. A point has neither length, nor breadth, nor thickness.

OF LINES.

Fig. 2. A line — length, without breadth or thickness. A continuation of points. Its extremities are called points.

Fig. 3. The place where two lines meet is also called a point. There are several sorts of lines.

Fig. 2. A straight line is the shortest distance from one point to another.

Fig. 4. A broken line is composed of straight lines.

Fig. 5. A curved line is neither straight nor composed of straight lines, but a continuation of points not in the same direction.

Fig. 6. A mixed line is composed of straight lines and curved lines.

Fig. 7. Parallel lines preserve always the same space. *between them*

Fig. 10. A vertical line is parallel to a plumb line.

OF ANGLES.

Angles are formed by the meeting of two lines; the point of meeting is called the summit of an angle, and the lines which form it are called its sides.

Figs. 8, 9. The letter placed at the summit of an angle serves to indicate it; thus we should say, the angle A, the angle B. The size of an angle does not depend upon the length of the sides but upon their divergence from each other. The angle A, is greater than the angle B.

There are several sorts of angles.

Figs. 10, 11. A right angle is formed by two lines perpendicular to each other.

Fig. 9. An acute angle is less than a right angle.

Fig. 8. An obtuse angle is more open than a right angle.

OF SURFACES.

A surface—length and breadth without height or thickness.

A plane surface can have a ruler applied to it in every direction.

A curved surface—neither plane nor composed of plain surfaces.

A polygon. A general name given to surfaces terminated by straight lines.

Fig. 12. A triangle is a polygon of three sides.

An equilateral triangle has all its sides equal.

An isosceles triangle has only two sides equal.

A scalene triangle has all its sides unequal.

A right angled triangle is that which has a right angle.

The side opposite to the right angle is called the Hypothenuse.

A quadrilateral is a polygon of four sides.

There are several sorts of quadrilaterals.

Fig. 13. A square has its sides equal and its angles right angles.

Fig. 14. A lozenge or rhombus has its sides equal without having its angles right angles.

Fig. 15. A rectangle has its opposite sides equal and its angles right angles.

Fig. 16. A parallelogram has its opposite sides equal, without having its angles right angles.

Fig. 17. A hexagon is a polygon of six sides.

Fig. 18. An octagon is a polygon of eight sides.

Figs. 13, 15. A diagonal is a line which joins the summits of two angles not adjacent.

OF A CIRCLE.

Fig. 19. A circle is a surface bounded by a curved line, named the circumference.

The circumference of a circle has all its points equally distant from an interior point, which is called the centre.

The radius is a straight line drawn from the centre to the circumference.

All the radii of the same circle are equal.

The diameter is a straight line passing through the centre and terminating at two opposite points of the circumference, as A B.

Fig. 20. The arc of a circle is a portion of the circumference, as C B.

The chord is a straight line which joins the extremities of the arc.

The diameter is the greatest chord which can be drawn in a circle.

The secting line is a straight line which crosses the circle and cuts the circumference in two points, as E F.

The tangent is a straight line out of the circle, and which can only touch the circumference in a single point M, which is called the point of contact.

OF SOLIDS.

A solid or body unites three dimensions, length, breadth, and thickness.

Fig. 21. A cube is a solid, formed of six equal squares.

Fig. 22. A prism is formed by right angles, having for base any polygon.

The base of a solid is the surface upon which it reposes.

Fig. 23. A cylinder is formed by the revolution of a rectangle, and having for base a circle.

Fig. 24. A pyramid is formed by triangles, and having for base a square.

Fig. 25. A cone is formed by the revolution of a right angle triangle, and having for base a circle.

Fig. 26. A sphere is a solid, bounded by a curved surface, all the points of which are equally distant from an interior point called the centre.

N.B. The instruments requisite for drawing in Perspective are hard pencils, a ruler with a sloping edge, a square, compasses with pencil and pen, a drawing pen, red and Indian inks. The drawings should first be done of a large size, with pencils, and when the pupil is perfect in the figure, &c.—they should be drawn in pencil on fine paper, rather larger than the engravings, the dotted lines in red and the figure in Indian ink.

PRACTICE.

To divide a line into two equal parts.

Plate II. Fig. 27. Let A B be the given line.

From the points A B as centres, and with a radius greater than the half of A B, describe two arcs which cut each other at C and D. A line passing through these points will divide A B into two equal parts.

To divide a line into a certain number of equal parts.

Fig. 28. Let AB be the line to be divided, into three equal parts for example. From the point A draw an indefinite line, AC forming any angle with AB ; with an open compass mark three points on AC , DEI , join the last point I with the point B , the extremity of the given line; from the points E D draw parallels to IB , and they will divide AB into three equal parts.

N.B. To draw parallels to IB , we must place the square in such a position that one of its sides will cover the line IB , place a ruler to the side GH , then holding the ruler steady, slide the square along and draw as many parallels as are required.

If we wish to raise perpendiculars to a given line, we must place the ruler against it, then sliding the square along the ruler to the point required, draw a line from the right angle of the square.

To make an angle equal to a given angle.

Fig. 29. Let A be the given angle, it is proposed to construct a similar one at the extremity D of the line DE .

From the points A D , as centres, and from the same radius taken at will, describe two arcs of a circle; take the size of the arc BC and bring it from E to F , join DF and the angle D is equal to the angle A .

To divide an angle into two equal parts.

Fig. 30. Let A be the angle to divide.

From the point A as centre and from a radius at will, describe the arc CB from these points as centres, and from the same radius describe two arcs, which are cut in E ; join the points A E by a line which will divide the angle A into two equal parts.

To determine the surface of a small picture in proportion to that of a large picture, the breadth of the small picture being likewise given.

Fig. 31. Let $ABCD$ be the large picture.

Draw the diagonal DB ; take the given side of the small picture and bring it from D to E ; from the point E , raising a perpendicular so as to join the diagonal, we shall have the point H ; EHI is the size of the small picture.

To construct a large picture in proportion to a given small one.

Let $DEHI$ be the small picture.

Prolong its side DE ; take the given breadth of the large picture, and bring it from D to C ; from the point C raise an indefinite perpendicular; draw the diagonal DH , and prolong it so as to meet the indefinite perpendicular, which gives the point B ; CB is the height of the large picture

To construct an oval, the two diameters being given.

Fig. 32. Let AB be the large diameter and CD the small. Take CE , the half of CD and bring this size from A to O ; divide OE , the difference of the two diameters into three equal parts; take one of the divisions and bring it from O to I ; from the points I A as centres, and with a radius equal to their distance, describe two arcs which are cut in G and in K , from the point B as centre; and with the same radius, describe an indefinite arc, which gives the point F ; from this point, and with the same radius, describe an arc which ceases at the points HL ; from the points G H , as centres, and with a radius equal to their distance, describe two arcs which are cut in M ; from this point M , and with the same radius describe the arc GCH ; from the points L K , and with the same radius describe two arcs which are cut in N ; this point is the centre of the arc KDL .

OF PERSPECTIVE.

Perspective is the art of representing on a surface called a picture, the outlines of objects such as they appear to us.

OF THE HORIZON.

The first thing to be done is to decide the horizon.

There are two sorts of horizon.

The visible horizon is determined by a line which seems to separate the sky from the sea.

The rational horizon may be placed at pleasure high or low.

The horizon is always situated on a level with the eye of the spectator.

EXAMPLE.

Plate III. Fig. 1. Supposing that the figures A B C look through a glass; the line D E would upon the glass have the appearance of the horizon to the figure A, as F G to the figure B, and H I to the figure C.

In compositions the horizon is placed at will. The Italians, in general, place it very high; the Dutch and the German painters, on the contrary, place it very low. It is immaterial whether it is placed high or low for a landscape, or an exterior view, but for an interior it is better to place it rather low; as we are more accustomed to see the lines of the ceiling descend than those of the floor to ascend.

The horizon serves to determine the height of the different objects which occur in the composition.

EXAMPLE.

Let us suppose a first figure being placed at will, and its head touching the horizon; (the ground, in perspective, on which it is placed is in a perfectly horizontal direction;) the heads of all the figures placed, no matter in what part, must equally touch the horizon. Now as we adopt the measure of five feet and a half for the standard of human height, so then the horizon should be placed

at five feet and a half in height, and it will cut all bodies whose base rests on the ground.

Plate IV. From a point A, taken at will, raise a tree and give it thirty-three feet in height.

From A raise an indefinite vertical line, the size A B, which is comprised between the point A and the horizon, being five feet and a half; and this being repeated six times, gives the height of the tree.

The height of the small temple is found in the same manner, and the five feet and a half from the base to the horizon will also assist in finding the breadth.

If the first figure given were divided in two by the horizon, it would be cut at two and three quarters feet, and all the objects which touched the earth would be the same.

If the first figure were beneath the horizon, and if, for example, the distance from its head to the horizon were equal to its height, the horizon would be placed at eleven feet in height.

An object can be enlarged by approaching its base to the horizon.

EXAMPLE.

A building being drawn, we can enlarge it by bringing its base nearer to the horizon, because then the distance from its base to the horizon being less, it can be repeated oftener in the height of the building.

Thus we may give to mountains a considerable elevation by bringing their base close to the horizon.

All the parallel vanishing lines are united at some one point of the horizon.

Horizontal lines are parallel to the horizon.

To find the apparent size of human figures placed on different surfaces in a picture.

Plate V. Fig. 1. The first figure being placed at will, at the

point A ; from the point A draw a horizontal line, so as to join one of the sides of the picture as at A' ; take the height of the figure and mark it from A' to A'' ; from the point F (where the horizon joins the side of the picture) and through the point A'' draw a line down to the base of the picture. This will form a vanishing scale. All the horizontal lines placed in this scale, will be the same as those comprised between parallels; the figure which is at the point B is equal to the figure A, as being upon the same parallel.

To continue. From the point C draw a horizontal line, which crossing the vanishing scale, will give C' C'' as the height of the figure.

The same process repeated will give the figures D, &c.

To find the height of figures placed on buildings.

To find the height of the figure placed at E. From the point E draw a horizontal line as far as the edge of the building, as at I ; from this point lower a vertical line to the base of the building, which gives O ; from this point a horizontal line will determine the height of the figure, as E' E''.

The same process will produce the same result at G.

To place figures lower than the first figure.

To find the height of the figure placed at F. From this point draw a horizontal line, as far as the base line of the step above as at O. From this point raise a vertical line O X, and from this last point X, draw a horizontal line, which crossing the vanishing scale, will give the size F'F'' as the height of the figure.

OF THE PRINCIPAL VANISHING POINT.

The principal vanishing point (which is falsely called *point of sight*) is always upon the horizon in front of the spectator's eye.

We call it the principal vanishing point, because it is generally the vanishing point of the principal object in a picture.

The horizontal lines always make right angles, with the lines which tend to the principal vanishing point.

OF DISTANCE.

The distance of a picture is the separation of the spectator's eye from the picture.

The point of distance is the point where the spectator is stationed.

Distance may be varied, because the spectator may be more or less remote.

EXAMPLE.

Plate III. If the spectator were placed at the point A, the distance A M would be greater than if this same spectator were placed at the point B.

In the pictures of great masters the distance greatly varies.

EXAMPLES.

In the marriage of Cana by Paul Veronese, it is equal to three times the size of the picture. Leonardo da Vinci generally took it equal to three times the width between the point of sight and the side of the picture, and sometimes as much as twice the width of the largest dimension of his picture. In the school of Athens of Raphael the distance is equal to the base of the picture. In the compositions of Poussin, it is equal to twice the width of the base. We imagine that the great masters did not trouble themselves about their distance, till after they had sketched their foreground and principal subject; then, to rectify this sketch and to add the subordinate parts in proportion, they sought out their distance.

There are many pictures in which the distance can be dispensed with.

When we work with a distance it is to be generally marked on each side of the point of sight, at equal distances from it. As it is nearly always out of the picture we more frequently make use of a half, a third, or a quarter of the real distance.

To draw from nature.

The distance must neither be too small nor too great. It is sufficient when we can perceive without turning away the head, all the objects which we wish to represent.

N. B. To see the whole of a building, we must be three times its height, at least, away from it.

To find the distance.

Front surface. This denomination is applied to all the surfaces which are parallel to that of the picture.

The vanishing surfaces make an angle more or less open with the front surfaces.

The front surface and the vanishing surface of a square building being given, to find the distance.

Plate VI. Fig. 1. The vanishing surface goes off to the principal vanishing point, which we shall always designate by P.

From the point E draw a line to P, and from B a horizontal line; these lines give C. A B C E is a perspective square placed horizontally; every time that the vanishing sides of a square tend to the point P, the diagonals of this square will go off to the points of distance. The diagonal of this square A C, prolonged as far as the horizon, will give the point of distance, which we shall always designate by D.

To find the half distance or any other fraction of it.

When the distance is not in the picture we take a fraction of it.

EXAMPLE.

From the point F, middle of A E, and through the point C, draw a straight line as far as the horizon, which gives the point of half distance, indicated by $D\frac{1}{2}$.

In the same way we can obtain a third, a quarter, or an eighth of distance, which may be thus expressed $D\frac{1}{3}$, $D\frac{1}{4}$, $D\frac{1}{8}$, &c. by dividing A E into three, four, or eight parts.

To determine the vanishing surface of a square building. The front surface and the $D\frac{1}{2}$ being given.

Fig. 2. From G draw a line to P; divide G H into two equal parts, and from the point of division L draw a line to the $D\frac{1}{2}$, which meeting with G P gives I. G I is equal to G H. If the whole distance were used the lines G P, H D would equally have given the point I.

To find the middle of a rectangle.

Plate VII. Fig. 1. Let S U V X be the rectangle. The meeting at Z of its diagonals will determine the middle point.

To find a rectangle equal to, and close to, one already given.

Fig. 2. Let B C F G be the given rectangle. From the point F and through the point E, the middle of B C, draw a line till it meets G B prolonged to the point of sight, which will give A; A B is equal to C F and the rectangles A B C D and G B C F are equal.

To find a rectangle equal to, but separated from, another rectangle.

Fig. 3. Let M H L N be the given rectangle, H I K L the space which separates it from the one to be drawn. First draw the diagonals L I, H K, then from the point N and through the point O, the middle of the diagonals, draw a line which will give J; I J is equal to N L, and the rectangles K I J R and L H M N are equal.

A square building being drawn, it is proposed to draw another square projecting over its sides, and serving to shew an Italian roof.

Plate VIII. Draw and prolong the diagonals of the square A B C D. Mark a point as at V; from it draw a line to U; from U and V draw lines to the point of sight P; join X to X', and V U X X' is the square required. From the point O, the centre of the square, and of course the centre of the roof, raise a vertical line. From the different angles of the square draw lines to the point E, and they will form the roof required.

To find on the vanishing surface of a square building a window, equal to one given in the front surface.

Form the rectangles F G H I and G L M H; draw the diagonals G I and L H. From the points 2 3 draw the horizontals, which give the points 4 5; then by drawing the lines 4 P and 5 P we obtain 6 7, the breadth of the window.

To place trees at equal distances, the two first being given as at A B.

Plate IX. Fig. 1. From the point A raise a vertical line; mark on this line the equal distances C E F H, &c.; from these points draw lines to the point P. From the point A and through the point G draw a line till it intersects a vertical line drawn from P; the points I K L thus procured will show the places for the third, fourth, fifth trees. To obtain a still greater number, draw a line from M, the base of the last tree to X, and proceed as before.

To place windows upon the front surface of a building.

Plate X. Fig. 1. Application of Fig. 28. Plate II.

To place windows on the vanishing surface of a building.

Fig. 2. Let A B be the vanishing surface upon which three win-

dows are to be placed, the distance between each window being the same as the breadth of the window. From the point A, draw an indefinite horizontal line; mark on this line seven equal divisions, beginning at A; from the last division 7, and through the point B, draw a line as far as the horizon, which will give the point F; from the points 6, 5, 4, &c. draw lines to F; these lines are vanishing parallels, and they divide A B into seven equal parts. From all the points of division, C, E, R, G, H, I, lower verticals, and we shall have the windows required. The same process, but altering the number of divisions, will serve for any number of windows.

To construct a floor of square flags.

Plate XI. Fig. 1. Divide the base of the picture into equal parts, and from all the points of division draw lines to the point P.

1st. If the distance be not determined—that is to say, if there is no object yet placed in the picture—we give to the first row any depth we please, by drawing the horizontal line A B. To find the depth of the other rows, we draw the diagonal of one of the squares as C E; its prolongation determines the other rows at the points F G, &c. To obtain a greater number, we must draw the diagonal H I from one of the last squares; the meeting of its prolongation, and of the lines which go off to the point P, will give the rows required; and so on to obtain a still greater number.

Remark. As soon as we have placed the first row, the distance is determined; we find it by prolonging the diagonal of one of its squares as far as the horizon. It is necessary, then, that all the objects we introduce into this picture should be subordinate to this distance, as we shall make it hereafter appear.

2d. If the distance be determined at the point D—for example, from the point C, draw a line to D—the meeting of this line and of those which go off to the point P, determines the depth of the rows at E F G.

If we work with the half distance, we must divide K' C', the breadth

of a square, into two equal parts, which will give L; from this point draw a line to the point $D\frac{1}{2}$, which, on meeting with C' P, gives A. C' A is the depth of the first row. Then draw the diagonal C E, and work as above.

Plate XII. Application of Plate XI.

Roofs to buildings.

Plate XIII. Divide A B into two equal parts, which will give E; from this point draw a horizontal line, and from C a line to the point P, which gives F.

If the distance be not determined, mark the point G; bring the size E G from F to H; from the points G H raise indefinite verticals; determine at will the points I J, by drawing a horizontal line; then join I A, I B, J C, &c. If the distance be determined at the point D—for example, from A draw a line to D, which, meeting E F, gives the point G. From the point B, draw a horizontal line, which gives the point L at its intersection with C P. From the point D, and through the point L, draw a line, which gives H; raise verticals from the points G H, and work as above.

Plate XIV. Fig. 0. From the point E, middle of A B, draw a line to the point P. If the distance be not determined, take the point G. From the point A, and through the point G, draw a line as far as the horizon, which will give the point of distance D. From the point B, draw a line to the point P, and from the point C, a horizontal line, which will give the point L. From the point D, and through the point L, draw a line, which will give F. From the points G F, raise indefinite vertical lines; determine at will the point I; from this point draw a line to P, which will give the point J; join the points I B, I A, J C, &c. From the point M, middle of A E, and through the point G, if we drew a line as far as the horizon, we should obtain the point $D\frac{1}{2}$; from this point, and through the point N, middle of L O, by drawing a line so as to meet E P, we should obtain the point F, &c.

Roofs and dormant windows seen in front.

Plate 15. Fig. 1. From the point B, middle of A C, raise an indefinite vertical line; mark the point E; draw the lines A E, C E, and prolong them till they meet the vertical, which passes through the point P, on which are marked the points P' P''. These points should be equally distant from the point P. From the point G, draw a line to the point P', and from E a horizontal line, which determines the roof at the point F. All the parallel vanishing lines, such as the lines A E, G F, H I, J K, &c. should be united at the point P'.

Remark. We shall always designate the points situated above the horizon, super-horizontal points; and the points situated beneath, sub-horizontal points.

To place a dormant window upon the roof of the building.

Fig. 1. Determine at will the front face, 1, 2, 3, 4, 5; from the points 3, 6, draw lines to the point P', and from the points 2, 1, lines to the point P, which will give 7, 8; join them by a line.

To place a dormant window upon the roof of the building.

Fig. 2. The inclination of the roof L M being drawn at will, form the vanishing face, N O R S T; from the points N U, draw parallel lines to the line L M; and from the points O R, horizontal lines; this will give the points X V; join them by a straight line.

Plate XVI. Fig. 1. From F, middle of B C, raise an indefinite vertical line; mark the height A, and draw the lines B A, A C; from the point P, and through the points A, B, C, draw indefinite lines; determine at will the depth of the roof at the point G, and draw G E, parallel to B A.

The jut B I is determined at will by drawing I H parallel to B A, and H J parallel to A C. For the projection G K, which is of the same size as B I, work as at Plate VII., Fig. 3.

Fig. 2. The breadth of the jut B I of the roof in front, figure 2, being given, we propose to draw I H parallel in perspective to B A, and H J to A C. From the point I draw a line to the point P; from F and C horizontal lines, so as to join the line I P; O F and J C are equal to I B; bring O F from A to H, and join the points I H, H J, &c.

To draw K L in parallel perspective to A B. From the point K, draw a horizontal line K M; from M, a line to the point P, which gives N; from K a line to the point P, and from N a horizontal line. The intersection of these two lines will give the point V; from V raising a vertical line, we shall obtain the point R; join the points R, K, &c. Work the same way every time it is wished to draw a line tending to the same point as the line A B.

Plate XVII. *Upon a square base to construct an octagonal pyramid, accompanied by four square pyramids.*

Draw the square A B C D, upon which construct a regular octagon.

Divide A B into seventeen equal parts; A E to contain 5, E G 7, and G B 5. Draw the lines G P, E P, as well as the diagonal A C, by which H I is obtained. Through these points drawing horizontal lines, we shall have K, L, M, N; then joining the points E K, L O, R M, N G, we shall have a regular octagon.

If the side G E is given on which to construct a regular octagon, we must divide G E into seven parts; mark five of these parts on the right, and five on the left, by which the points A B will be obtained; from the square A B C D, work as above.

To form the pyramid. From the point T, as centre, raise an indefinite vertical line, mark the height desired as at S, and draw the lines N S—G S—E S—K S—L S, &c.

To form the small pyramids. From the points 2, 3, 4, raise indefinite vertical lines, mark the height as at 5; from this point a horizontal line will give the point 6 from 6 to P, and the point 7 will

be found; then join the lines 5 B—5 G—5 V—6 E—6 A—6 K—7 X—7 L—7 D, &c. To draw the line G Z, join the point 2 middle of G N, with the point S, the intersection of this line with 5 V will give the point Z, &c.

To construct a continuation of semicircles forming an arcade.

Plate XVIII. Fig. 1. The semicircle A, O, B, being given, from the lines A, C, B, draw lines to the point P; from the point E, the distance of the next semicircle, draw a horizontal line E F—the intersection of this line with C P gives G; from this point as centre and from a radius equal to G E, describe the second semicircle.

To place a third circle equally distant from the second. From the point B and through the point G, draw a line so as to meet A P, which will give the point H. E H is equal to B F. From the point H draw a horizontal H J, which will give the point I at its intersection with C P; from the point I as centre and with a radius equal to I H describe the third semicircle; from the point F and through the point I, draw a line to join A P, this will give the fourth semicircle, and so on with as many as are required.

Fig. 2 Is the same as figure 1, but the spectator being in a different situation, only part of the arcade is seen.

Remark. The operation to place the semicircles at equal distances is absolutely the same as that in plate VII, Fig. 2.

All the lines which make angles of 45 deg. with the base of the picture unite at the points of distance.

To construct a floor of square flags, the sides of the flags forming angles of 45 deg. with the base of the picture.

Work as at Plate XI, then draw the diagonals of each square; these diagonals will be the sides of the flags.

To construct vanishing semicircles.

Plate XIX. Fig. 1. The vanishing diameter being given as well

as the half distance. From the points A B, raise indefinite vertical lines; from the point A, draw a line to the $D\frac{1}{2}$; this line meeting with that which is raised from the point B, gives the point C—from the point P and through the point C, draw a line and E will be obtained and the rectangle A, E, C, B. Draw the diagonal E, B, its intersection with A, C, gives F; from this point raise a vertical line, so as to meet E P, which will give the point 3; divide A E into five equal parts; from the point G, the first division, draw a line to the point P, its intersection with the diagonals gives the points 2 4; draw the curve of the semicircle through the points A, 2, 3, 4, B, &c. If the distance is not determined previously, the rectangle A, E, C, B, will decide it.

Remark. Prolonging the diagonal A C so as to meet the vertical raised from the point P, we obtain the $D\frac{1}{2}$.

The depth of an arch being given as A B, as well as a pillar B, I, it is proposed to find some more arches, &c. in the same proportion.

From the point I, draw a line to the $D\frac{1}{2}$, which will give the point J; L J is the depth of the second arcade, prolong J I so as to meet a vertical lowered from the point B, this will give the point H. From this point draw a line to the point P, the intersection of this line and that which is lowered from the point J gives the point N; from this point draw a line to the $D\frac{1}{2}$, which will give the depth of the second pillar at the point O, and the depth of the third arcade at the point R, &c. To trace the curves of the semicircles, work the same as for that of the first, the line G P, will serve for all.

To form semicircles parallel to given semicircles, C. B. being the breadth which should exist between them.

Plate XIX. Fig. 2. From the point P, and through the point C, draw an indefinite line, this line forms with A B a vanishing scale, &c.

To draw a semicircle parallel to A, O, B.

Take at will upon this last a point as E, from this point lower a vertical line, so as to join A P, which gives F; from this point draw a horizontal line which will give G; from the point G, raise a vertical line, and from the point E, draw a horizontal line, which will give H, the point required for tracing the curve. In the same way many other points may be obtained. To form the other parallel circles, from the points E H, draw lines to the point P; the intersection of the second semicircle and of the line E P, gives K; from this point, drawing a horizontal line to meet H, P; L will be found the point for drawing the curve, &c.

To trace a semicircle round a given semicircle.

Plate XX. Fig. 1. Let A, O, B, be the given semicircle. O, M, the distance which is to exist between the two semicircles. From the point C, centre of the semicircle, and from a radius equal to C M, describe a quadrant of a circle which will give the point S at its intersection with a horizontal line drawn from the point C; take O M and bring it from C to F; from the point P, and through the point F, draw an indefinite line; from the points A, B, draw horizontal lines, so as to meet P F, which will give the points K, L; from the point S, and through these points draw lines to P C, which will give J T, the points of the curve. From a point R, taken at will, lower a vertical line, so as to join P, C, which will give N; from this point draw a horizontal line, which will give I; take the size N, I, and bring it from R to V; from the point C and through the point R, draw a line; also, from the point S and through the point V; their intersection will give X the point for the curve. After, obtaining several other points in the same way, trace the curve required.

To divide a semicircle into twelve equal parts.

Fig. 2. Let A B E be the semicircle, to be divided into twelve

equal parts. From the point C the centre of the circle and from a radius equal to C B—describe a quadrant so as to meet a horizontal line drawn from the point C, which will give F; divide the arc B F into six equal parts, which will give the points 1, 2, 3, 4, 5; from these points draw horizontal lines far enough to meet the line B C, by which means the points I, H, G, O, B will be obtained; from the point P, and through these points draw lines, which, meeting the curve of the semicircle, give the points J, K, &c.

Remark. The lines M, N, K, &c. all centre in the point C.

To construct the opening of a window on the ceiling of an arch.

Plate XXI. Fig. A B the breadth of a semicircle being given, construct a vertical semicircle by the means shewn in Plate XIX. Fig. 1; then from a point as G upon this circle, lower a vertical line, so as to touch A, P, which will give O; from this point draw a horizontal line which will give H at its intersection with C, P; from the point H as centre and with a radius equal to H, O—describe a semicircle, and from G, drawing a horizontal line we obtain E, a point of the curve required. In the same way many other points may be obtained.

To construct an arched roof with the arches meeting in the centre at right angles.

Plate XXII. From the square A B C E and from its right angles, raise indefinite vertical lines; form the square A' B' C' E' the sides of this square touch the semicircles; draw the diagonals A' C' B' E', their intersection will give O, the point of meeting of the curves. Mark a point on the first semicircle as at H; from this point draw a horizontal line so as to join the lines A A', B B', the points A'' B'' will be thus found; draw the square A'' B'' C'' E'' and the diagonals A'' C'' B'' E''; from the points H G draw lines to P, their intersection with the diagonals will give the points 2 3 4 5. Draw the curve

through the points A 2, O 5 C, &c. More points may be obtained in the same manner to facilitate the drawing of the curves.

To form the two vanishing semicircles.

From the point O draw a horizontal line, so as to join the lines A' E' B' C', which will give the points M N; from the points 2 4 3 5 draw horizontal lines, so as to meet the lines A'' E'' B'' C'', which will give the points T K L S. Draw the curve of the semicircles through the points A T M K E, B S N L C, &c.

To construct three vanishing semicircles, the middle one being larger than the others, as the arches of a bridge.

Plate XXIII. The first semicircle being given; B C is its breadth. Divide C E into a certain number of parts; into four for example. From the point B and through the point G, draw a line till it meets with the vertical line drawn from P, which will give the D 8; to find C F, equal to B A, work as at Plate VII. Fig. 3. To find the breadth of the second semicircle, its height F I, being given, divide F I into four equal parts, which will give J; from this point draw a line to the D 8, which will give K at its intersection with I P; from this point lower a vertical line, then form the semicircle in the rectangle F I K L. To find the breadths L M, M N, N O, equal to F C, C B, B A, draw the diagonals L I, F K, which will give X; from the points E T V, and through the point X draw lines, which will give the points M N O on their meeting A P, &c.

Remark. If from the point B and through the point E we were to draw a line, and it should meet a vertical line drawn from the point P, it would be unnecessary to divide E C into equal parts, as the point of meeting would be the $D\frac{1}{2}$.

To construct a staircase seen sideways, or steps to a door.

The height A B and the breadth B C of the first step being given at will.

Plate XXIV. Fig. I. From the point A and through the point C draw an indefinite line; from the point B draw a parallel to this line. All the verticals and horizontals comprised between these parallels will be of the same size, &c. From the point C raise a vertical line C E. From the point E draw a horizontal line E F, which forms the profile of the second step, and so on for all the others. From all the points A B C, &c. draw lines to the point P. Decide the width of the stairs, and raise a vertical line A' B'. From the points A' B' draw parallels to A F, these parallels will give the points C' E' F' on meeting the lines which tend to the point P.

For the rails.

From the point G' draw a line to the point P which will give J, then draw the lines G' H, J K parallel to A F. From each step raise vertical lines, &c.

To construct a staircase seen in front.

Plate XXV. A B the height, and B C the depth of the first step, being given. From the point A raise an indefinite vertical line; take the height A B and repeat it as many times as there are steps required. From the points 2 3, &c. thus obtained draw lines to the point P. From the point A and through the point C draw an indefinite line, which will give the points E F, &c. on meeting the lines 2 P, 3 P; draw the vertical lines C G, E H. From the points C G E H F draw indefinite horizontal lines, and finish the second side in the same manner.

Remark. The lines A F, A' F' should be united on the vertical line drawn from the point P.

To construct Gothic arches seen in front.

Fig. 2. Let I J be the breadth of the first arch. From the points I J as centres, and with a radius equal to their distance, describe two

arcs which intersect each other in K. I K J is the first arch. To find the second side of the arch, from I J draw lines to the point of sight P. Mark the thickness of the archway as at M, draw a horizontal line to L, and from these points as centres draw two arcs, which will intersect each other at the point N; a line drawn from K through N, will go to the point P. Y I' being found (equal to Y I by drawing lines to the point P, and a diagonal line to the point D) it is proposed to find I' I'' equal to I J. Draw a line from the point J to any part of the line U R Y as at S, this will give the point X; from this point draw a horizontal line X Y'. From the point Y' draw a line to the point P, which gives V'; draw a line which gives I'' and E''; from the point S', drawing a line to the point F'', we obtain the points N' T'', &c. and so on.

To construct vanishing pointed arches.

Divide the half of I J into equal parts—into three for example. From the points of divisions raise vertical lines so far as to meet the curve I K, which gives the points X V. From the points I X V K draw horizontal lines, so as to touch the vertical line S U, which will give the points U R T Y; from these points draw lines to the point P. Divide T' Z' into six equal parts by the means shewn in Plate X. Fig. 2. From the points of division 2 3 4, &c. lower verticals till they meet the lines R P, T P, which will give the points A B C; draw the curves of this arch through the points I' A B 4 C E I''. Work the same for all the others.

Staircases, or steps cutting each other at right angles.

Plate XXVI. Form the profile of the steps as in Plate XXIV; from all these points draw lines to the point P. Determine the depth of the first part of the flight of steps, as at the point B'. If the distance is determined, from the point B' draw a line to the point D; its intersection with C P gives C; raise a vertical line C' E'; from the point

E' draw a horizontal line E' E''; draw the lines A' C' B' E', and prolong them indefinitely, these meeting F P, G P give F' G', and a greater number of points if there were more steps. If there is the D $\frac{1}{2}$ from the point B' draw a horizontal line so as to meet C P, which will give H; divide B' H' into two equal parts, which gives O; from this point draw a line to the D $\frac{1}{2}$, which meeting with C P gives C', and work as above. If the distance is not determined we take at will the point C'. To terminate this staircase by a landing, of which G I is the breadth, from the point I, draw a line to the point P.

A staircase turning in the angle of a wall.

Plate XXVII. Repeat the height of the first step A B upon the vertical line, raised from the point A, which will give the points 2 3 4 5, &c.; from these points draw lines to the point P; repeat these same sizes upon the vertical line, raised from the point B', which will give the points 2' 3' 4' 5', &c.; determine the breadth of the first step as at C, from this point raise a vertical line C E; join the points C B' E 2'; from the point A and through the point C draw a line which will give the points F G; raise the vertical lines F H, G I; join the points F 2' H 3', G 3', I 4'; the line G L' is the angle of the wall. From the point I, draw a horizontal line, and from the point 4' a line to the point P, which will give J; divide I J into three equal parts because there are three steps from B to G. From the points K L draw horizontal lines, and we shall have the profile I M N O R; join the points M 4', N 5', O 5', R 6', &c.

Remark. By prolonging as far as the horizon the line 4' I, we can obtain the point of distance.

To open a door.

Plate XXVIII. Let A B be the door-way. From the point D $\frac{1}{2}$ and through the point B draw an indefinite line; from the point A draw a horizontal line which will give the point O; take the size

A O, and bring it from O to E; from the point P and through the point E draw a line, which will give G, on meeting B O prolonged; draw the horizontal lines G C and B C' and we shall have two squares, B C' E A, and A E G C, in which a semicircle must be traced B E C. Let A H be given for the base of the door, this line is equal to A B, being a radius of the same circle, &c. Prolong H A as far as the horizon, which gives F; from this point and through the point I, draw a line and from H raise a vertical, which will give J and terminate the door.

Remark. The base of a door must always begin from the centre and is comprised in a semicircle, which has for radius the width of door-way.

To open an escrutoire.

From the points *h n*, draw horizontal lines; from the point *h*, as centre, and with a radius equal to *h f*, describe a quarter circle *f i*; from the point *n* as centre, and with a radius equal to *n p*, describe a quarter circle *p k*; join the points *i k* by a straight line which should go to the point P, the vanishing point of the front of the escrutoire.

To find the base of a chair.

Construct the square *e g m f*; from its angles raise vertical lines, &c.

To form a floor of octagon and square flags.

If we wish to place four octagons from P to C, divide this space (by the method indicated by Plate II. Fig. 28) in such a manner that C K contains five equal parts, K L seven of these parts, L A five, A M five, M N seven, &c.; from the points C K L, &c. draw a line to the point of distance which gives the point B and the diagonal C B; wherever this diagonal intersects the lines going to P, draw horizontal lines and thus we obtain squares, on which by drawing diagonals we obtain the figure required.

Plate XXIX. Fig. 1. The geometrical figure of Plate VII.
Fig. 2.

To find a rectangle equal to a given rectangle, and touching it.

If from the point F, and through the point E, middle of B C draw a line so as to meet B P, we shall obtain the point A. A B is equal to F C, &c.

Fig. 2. Is the geometrical figure of Plate VII. Fig. 3.

To find a rectangle equal to a given rectangle but not touching it.

If we draw the diagonals H K, L I, we shall have the point O; if from the point N and through the point O we draw a line till it meets M T, we shall have the angle I T equal to N L.

Fig. 3. The geometrical figure of Fig. 1. Plate VIII.

To surround a given square with another.

Prolong the diagonals—mark the distance required between the squares and draw parallels to U V X Z; A B C D, square required.

Remark. We can form as many squares as we wish by ending their sides at the prolongation of the diagonals of the given square.

Fig. 4. The geometrical figure of Plate XIX. Fig. 1.

To construct a semicircle.

The semicircle A 2 3 4 B is inscribed in a rectangle formed by two squares, A E 3 1, 1 3 C B.

If we draw the diagonals, A C B E, and if, through their intersection, 2 4, with the curve of the semicircle, we draw the line G H, we shall see that the size G E is equal to the fifth of the line A E, the height of the semicircle.

Remark. A semicircle is always inscribed in two squares which touch each other.

Fig. 5. The geometrical figure of Plate XXX. Fig. 1.

To construct a circle.

The circle $B C D A$ is inscribed in a square $F G H E$. If we divide this square into two equal parts $E H C A$, $A C G F$, and also draw the diagonals $F C$, $G A$, $A H$, $C E$, we shall have the points $J K$, $I L$; if from the point A , and through the point J , from the point C , and through the point K , we draw lines so as to meet the line $F G$, we shall have the points M , N , each on their side at the quarter of the line $F G$; if from the points J , K , we draw parallels to F , E , they will go to the points J , L , &c.

To construct a vanishing circle.

Plate XXX. From the square $G F H T$, draw diagonals to obtain the point O as centre; through this point draw the lines $A C$, $B D$, which will give the points $A C$, $B D$. Draw the diagonals $F C$, $G A$, $A H$, $C T$; divide $F G$ into four equal parts which will give the points M , N ; draw the lines $M A$, $N C$, and we obtain the points $J K$, on meeting the diagonals $F C$, $G A$, from the points J , K , draw lines to the point P , which will give the points I , L ; on meeting the diagonals $T C$, $A H$, draw the curve of the circle through the points $A J B K C L D I$.

To surround a given circle with a circle.

Plate XXXI. Let $A B E D$ be the given circle; the distance $A a$ is that which is to exist between the two circles.

From the centre O raise an indefinite vertical line; take, at will, upon this vertical line the point S and join it with the point a ; from the point A raise a verticle so as to meet the line $a S$, which gives the point C ; prolong the line $A E$, so as to meet one of the sides of the picture; as far as the point G for instance, take the size $A C$, and bring it from G to H ; take the point F , at the intersection of the line of horizon, with this side of the picture; from this point, and through

the point H, draw an indefinite line; the lines G F, H F, form a vanishing scale; all the horizontal lines comprised in this scale will be of the same size, and equal to the line H G. From a point taken at will, as at I, upon the curve of the given circle, draw a horizontal line just so far, and comprised within the vanishing scale, which will give the size J K; bring this size from I to L on a vertical line raised from the point I; from the centre O, and through the point I, draw an indefinite line; from the point S, and through the point L, draw a line so as to meet the line O I, which will give the point M; the place of the curve required.

Obtain in the same way as many points as are deemed requisite.

To divide the circumference of a vanishing circle into equal parts.

Let A B C D be the circumference of the circle which is to be divided into sixteen equal parts.

Plate XXXII. From the point O, centre of the circle, and from a radius equal to O A, describe a semicircle; divide the curve of this semicircle into eight equal parts; from the points of division, 1, 2, 3, 4, 5, 6, 7, lower vertical lines, so far as to meet the diameter A C, which will give the points, E F, G H, I J; from the point P, and through these points draw lines, which will give K, L, M, N, R S, and will divide the circumference of the given circle into sixteen equal parts.

Remark. The lines S T, R U, N V, &c., always go off to the point O, centre of the circle.

Plate XXXIII. *To construct circles parallel to given circles.*

The circle of the summit of the tower is formed in the same manner as that of Plate XXX. Through the point G', taken at will, it is proposed to draw another circle. From the point G' raise a vertical line, so as to touch the curve A O B, which will give G; from this point draw a line to the point P, which, meeting the diameter A B

gives the point H; from this point lower a vertical line, and from G' draw a line to the point P, which will give H'; through this point draw the diameter A' B'; take at will upon the circle A O B a point I; from this point draw a line to the point P, which will give J on meeting with the diameter A B; from the point J lower a vertical line, which gives J' on meeting the diameter A' B'; from the point P, and through the point J', draw a line so as to meet the vertical line drawn from the point I, which will give the point I', the point of the curve required. Obtain in the same way as many points as convenient, and draw the curve, &c.

To place figures on broken ground, the base of which is not seen.

When we do not see the base of the ground upon which they are placed, we can give them any size we please, because we cannot then measure their distance, which may be greater or less; we must simply endeavour to make them in proportion to the objects near them, &c.

Plate XXXIV. *To place a great number of parallel horizontal circles at equal distances.*

Fig. 1. Take at will several points upon the higher circle; from these points, A, D, E, C, &c. lower indefinite vertical lines; divide each of these vertical lines into the same number of equal parts, from the points A, D, E, C, &c. as far as the horizon, which will give the points A, A', A'', &c., D, D', D'', &c., E, E', E'', &c.; joining the corresponding points by curves, we shall have the circles required.

To obtain the circles below the horizon, we must repeat the divisions of the vertical lines below the horizon, and join the corresponding points.

Remark. In a round tower it is always the circle the farthest from the horizon which determines the appearance of the tower; consequently, it is as well to establish it the first.

Having drawn several circles on a round tower, it is proposed to draw a larger one round one of them.

Let A'a be given for the distance which is to exist between the two circles. From the point a, and through the point A'', draw a line, so as to join a vertical line from the point O, centre of the given circle, which will give the point S; from the point O, and through the point D', draw an indefinite line; from the point D' lower a vertical line, which will give the point D'' on meeting the circle A'' D'' C'', &c.; from the point S, and through the point D'', draw a line, which will give the point d at meeting the line O D'; d is a point of the curve. Obtain in the same way as many points as are deemed requisite to assist in drawing the curve.

Fig. 2. Through the point F it is proposed to draw a line in perspective, parallel to the line G I; this line is to go off to a point situated out of the picture, above the point P.

From the point I lower a vertical line as far as the base of the wall, and from the point G draw a line to the point P, which will give the point H; from the point F draw a line to the point P, which will give the point H'; from this point raise a vertical line, and from the point I draw a horizontal line, which will give the point I'; join the points F I' by a line, which will go off to the same point as G I.

To divide a line into equal parts. (This line goes off to a point above or below the horizon.)

Let G I be the line which is to be divided. Divide I H into equal parts, as many as those into which we wish to divide I G; from the point P, and through all the points of division, draw lines so as to meet the line I G; they will divide this line into equal parts.

CIRCULAR STEPS.

Plate XXXV. Let A B C be the given circle, B D the height of the steps, and D E the breadth. From the point B, and through the point E, draw a line far enough to join a vertical line raised from the

point O, centre of the given circle, which will give the point S; from the point D draw a parallel to B S, which will give the point S'; from the point P, and through the points 2, 3, 4, draw indefinite lines; from the point A raise a vertical line, which will give A' on meeting the line P 2. To determine the size A', a equal to D E. Repeat the $D\frac{1}{4}$ upon the vertical line lowered from the point P, by describing a quarter circle from the point P as centre; take the quarter of the line D E, and bring it from O to O'; from the point P, and through the point O', draw a line, which will give the point d ; from this point draw a line to the point $D\frac{1}{4}$, which will give e , at the intersection of the line A P; from the point e raise a vertical aa' ; from the point A draw a line to the point S, and from the point A' a line to S', which will give $a'' a'''$, &c.; from the $D\frac{1}{4}$, and through the point C, draw a line far enough to meet a line drawn from the point d to the point P, which will give d' ; from which point we raise the vertical line $d' d''$, &c.; draw the lines C S, C' S'. As the points thus obtained will hardly suffice for the curves, we must continue the operation thus. Mark a point as I upon the given circle; from this point draw a line to the point P, which will give the points J K; from the point J raise a vertical line so as to meet the line $D\frac{1}{4}$, which will give the point J'; from the point P, and through the point J', draw a line so as to meet a vertical line raised from the point I, which will give the point I'; from this point draw a line to the point 2; its intersection with the line drawn from the point I to the point S, will give the point L; I' L is the breadth of the first step. From the point L raising a vertical line to join the one drawn from the point I' to the point S', we obtain the point L'. L L' is the height of the second step. From the point L' drawing a line to the point 3, we obtain the point L''. L' L'' is the breadth of the second step, &c. From the point K raise a vertical line so as to meet the line I' P, which will give the point K'; draw the lines K S, K' S'; from the point K' draw a line to the point 2, which, meeting the line K S, gives the point K''. K' K'' is the breadth of the first step. From the point K'' raise a vertical line

so as to join the line $K' S'$; we thus obtain the point K''' : for the height of the second step, draw the curve of the first step through the points A', I', D, K' ; draw the curve of the breadth of this step through the points a, L, E, K ; the curve of the height of the second step through the points a', L', F, K''' , &c.

Remark. The triangles $A A' a, I I' L—B D E$, &c. are absolutely the same; they have a vertical side, and this side stretches to the point 2, and a side which tends to the points S , &c.

AMPHITHEATRICAL STEPS.

Plate XXXVI. The semicircle A, O, A'' , being given as well as the profile $A A'—B B'—C C'$, mark upon the horizon a point as at F . From this point draw lines to the points a, b, c, d . The meeting of the line $a F$ with the given circle, will give the point E ; from this point by raising a vertical line as far as the line $b F$, we obtain F for the height of the second step. Draw the line $D A$, and prolong it so as to meet the central vertical line $d a$, which will give the point S ; from this point and through the point E , draw an indefinite line which will give the points $G I L$ depth of the second, third, and fourth steps, at its junction with the lines $b F, c F, d F$; from the points $G I$ raise vertical lines which will give the points $H J$ height of the second and third steps. In the same way obtain as many points as are desirable to trace the curves of the steps correctly.

Remark. If we mark several points on the curve $D' L, D'$, and through these points elevate vertical lines as far as the horizon, then dividing them into equal parts, we shall have points to draw curves. If we wish to continue these curves above the horizon, we must repeat the points, &c.

To measure a line which goes off to the principal vanishing point.

Plate XXXVII. Let $A B$ be the line we wish to measure, the point $D \frac{1}{2}$ being given. From the point A draw an indefinite horizon-

tal line ; from the $D\frac{1}{2}$ and through the point B draw a line, which on touching the indefinite horizontal line will give the point C; the line A C, is equal to half A B, because we have the $D\frac{1}{2}$. Thus, A C is 20 feet, (or about four times the height of the human figure,) and A B is 40 feet.

If the line $D\frac{1}{2}$ B, did not join in the picture the line A C, we must then draw a line from the point A to the $D\frac{1}{2}$, and from the point B a horizontal line, which would give the point E. B E is equal to the half A B, &c.

Another Method.

Plate XXXVIII. Repeat the point $D\frac{1}{2}$ upon the vertical raised from the point P, by describing a quarter of a circle from the point P as centre; from the point A draw a line to the point $D\frac{1}{2}$, the meeting of this line and of the the vertical line raised from the point B gives the point C. B C is equal to the half of A B.

If we take G H, half of G F and bring this size from G to I, and from I draw a line to the point $D\frac{1}{2}$, its intersection with the G P will give the point J depth of the tower. G J is equal to G F.

To construct a cornice and mouldings.

Plate XXXIX. Let A, B, C, D, E, be the profile and placed at the point H, the middle of F G. From the point F, draw a horizontal line far enough to meet a line drawn from the point P, and through the point A, which will give the point J. As we have the point $D\frac{1}{3}$ we must divide I F, into three equal parts which will give the point J; from the point $D\frac{1}{3}$ and through the point J draw a line which will give the point A'; join this point with E', the line A' E' is the same as A E; from the points B D draw lines which will give B' D' on joining A' E'; from the point B' lower a vertical line as far as P C, which will give the point C'; draw horizontal lines through the points A' B' C' D' E'.

To form the most distant angle of the cornice, from the point G, draw a horizontal line G K—divide it into three parts, which will give M; from this point draw a line to the point $D\frac{1}{3}$, which will give N on touching G P; from this point draw a horizontal line N, A'', join this point with E'' and we shall obtain the points B'', D''; from the point B'' lower a vertical line, which gives C'' on touching the line C P; from the point C'' draw a horizontal line C'' C''', this line passes behind the edifice.

To trace the mouldings of a pediment the same as those of a given cornice.

Plate XL. Fig. 1. A S, the half of the front of the roof being given going off to a certain point F. Draw vertical lines from the points A, B, C, D, E; from the point S draw a horizontal line. Draw the profile *a, b, c, d, e*, as in Fig. 2, the same as A, B, C, D, E, as we have the $D\frac{1}{2}$ divide F P into two equal parts, which will give the point $F\frac{1}{2}$; join this point with the $D\frac{1}{2}$ —form the angle *m, e, n*, equal to M $D\frac{1}{2}$ N, by the method formerly indicated. Prolong the line *a, h*, so as to meet the line *e, n*, which will give *h'*, take the size *e, h'* and bring it from *h''* to *e'*—draw the line S *e''*, and form the profile S 2 3 4 *e''* (we obtain the points 2, 4, at the intersection of the line S *e''* with the vertical raised from the points B D, &c); from the point F and through the points 2, 3, draw lines so as to join A' A'."

As we have not the sub-horizontal vanishing point of the line S A'' draw from the points 4 *e''* lines to the point F; divide F *e'* F into two equal parts, which will give the points S *e'''*, join these points by a line which must be parallel to S *e''*; from the point 2' lower a vertical line, and form the profile S 2', 3', 4', *e''*, from all these points draw lines to the point P, and from the points 2, 3, 4, *e e'*, draw parallels to these lines. Pay great attention to the corresponding lines. 2 2'' is parallel to 2' P and so on.

Plate XLI. We call central ray of the eye, a ray drawn perpendicularly from the eye of the spectator to the picture.

Fig. 1. The lines which go off to the principal vanishing point are parallel to the central ray of the eye; we represent them in geometry by lines perpendicular to the base of the picture—thus, A' B' represents A B, &c.

All the horizontal lines remain horizontal lines in perspective as in geometry; they make right angles with the lines which go to the principal vanishing point. Thus the angles E A B, A B C, are right angles.

The lines which go off to the points of distance make semi-right angles with the central ray of the eye. They are represented by the lines which make half right angles with the base of the picture. Thus I' J' represents I, J, and I' K' represents J K.

To bisect the right angle formed by a horizontal line, and a line which goes off to the principal vanishing point; we must draw a line to one of the points of distance. Thus, to bisect the angle E A C, from the point E, draw a line to the point D. To bisect the angle A B C from the point E' and through the point B, draw a line which is prolonged indefinitely.

From a given point it is proposed to construct a square of which the sides make angles of 45° with the central ray of the eye.

Fig 2. From the point I' draw lines to the points of distance determine at will, the length of a side, at the point J for example, from this point draw a horizontal line J K; from the points J K draw lines to the points of distance in such manner that they cross each other, which will terminate the square at the point L.

Remark. In this square, one diagonal is horizontal, and the other goes off to the principal vanishing point.

The same proposition with the fraction of the distance. The $D\frac{1}{3}$ for example.

Plate XLII. From the point I, draw a line to the point P; divide I P into three equal parts, which will give I'; from this point

draw lines to the points $D\frac{1}{3}$, and from the point I draw parallels to these lines; mark at pleasure the point J; from this point draw a line to the point P, which joining $I' D\frac{1}{3}''$ will give J' ; from this point draw a line to the point $D\frac{1}{3}$; through the point J, draw a parallel to $J' D\frac{1}{3}$, which will give the point L; from the point J, draw a horizontal line, which will give K; join the points K, L.

It is proposed to draw a line which should make a right angle with a given line, this last going off to any point of the horizon.

Plate XLIII. Let the line B C be given as well as the point of distance. Prolong the line B C as far as the horizon, which gives the point A, which we shall call the accidental point. Repeat the distance upon the vertical raised from the point P, which gives the point D'; join this point with the point A, and draw the line D' A' perpendicular to D A. The angle C B E is a right angle, the same as the angle A D' A', which is the geometrical figure.

Remark. The nearer the point A is to the vanishing point, the further the point A' will be from it.

To bisect the perspective angle E B C, it is necessary to bisect the angle A D' A' by the method indicated Plate II., Fig. 29. The line D' F, which divides it, should be prolonged as far as the horizon, which will give the point F; draw the line F B; it will divide in two the angle E B C.

To draw a line which makes right angles with a given line, B C, and work with a fraction of the distance, $D\frac{1}{2}$ for example :

From the point B draw a line to the point P; divide it in two, because we have the $D\frac{1}{2}$; this will give the point O. From this point draw a parallel to B C, which will give the point $A\frac{1}{2}$. Repeat the $D\frac{1}{2}$ upon the vertical raised from the point P, which will give the point $D\frac{1}{2}'$. Join this point with the point A, and from the point $D\frac{1}{2}$ draw

a line, which will make a right angle with $A\frac{1}{2}$, $D'\frac{1}{2}$; this will give the point $A\frac{1}{2}$. Join this point with the point O, and through the point B draw a parallel to this line, and we shall have the angle C B E, which is a right angle.

A line, B C, being given, as well as the direction of a line, B C, we suppose that they make right angles. It is proposed, first, to find the distance, or a fraction of the distance; 2ndly, to determine B E equal to B C, and to form a square.

Plate LXIV. From the point B draw a line to the point P; bisect it, which will give the point b ; through this point draw, as far as the horizon, parallels to B C, B E, which will give the points $A\frac{1}{2}$, $A'\frac{1}{2}$; bisect the line $A\frac{1}{2}$ $A'\frac{1}{2}$, which will give the point H; from this point as centre, and from a radius equal to H $A'\frac{1}{2}$, describe a semicircle, which will give the point $D\frac{1}{2}$ on its joining the vertical line raised from the point P.

Bisect the angle $A\frac{1}{2}$ $D\frac{1}{2}$ $A'\frac{1}{2}$ by drawing the line $D\frac{1}{2}$ F, which will give the point F; join this point with the point b , and from the point B draw a parallel to this line. From the point C draw a line to the point P; its meeting with $A\frac{1}{2}$ gives the point c . From this point draw a line to the point $A\frac{1}{2}$; and from the point C, a parallel to this line, which will give the point G, when it joins the line B G. From the point $A\frac{1}{2}$, and through the point 4, at the intersection of the lines c , $A'\frac{1}{2}$, b , F, draw a line, which will give the point e , when it joins b , $A\frac{1}{2}$. From the point G draw G E parallel to 4 e , which determines B E equal to B C. Thus can be formed a square seen accidentally.

To construct a square building seen accidentally.

Plate XLV. Construct the square E B C G by the method given in the last plate; then, from the points E B C G raise vertical lines; determine the height of the building as at the point B'; from the point B draw an indefinite horizontal line. Take at will the point M;

from this point raise a vertical line far enough to join a horizontal line drawn from the point B' , which will give the point M' ; from the points M, M' , draw lines to any point of the horizon—to the point F , for example; these lines form a vanishing scale, which we call scale of elevation. All the verticals comprised in this scale will be equal to the line $M M'$, &c.

From the points E, C, G , draw horizontal lines, so as to join the line $M F$, which will give the points N, R, T . From these points raise vertical lines, till they reach the line $M' F$, which will give the points N', R', T' . From these points draw horizontal lines to meet the vertical lines raised from the points E, C, G , which will give the points E', C', G' , &c. Through these points draw the lines $E' G'—G' C'—C' B'—B' E'$ —which will form the square $B' E' G' C'$. If through the point H we wish to construct a square, we should work the same. From the point H let a horizontal line be drawn to join the vertical line $M M'$, which will give the point L . From this point draw a line to the point F ; its intersection with the vertical lines $N N'—R R'—T T'$ —will give the points O, S, V . Through these points let horizontal lines be drawn, so as to join the vertical lines $E E'—G G'—C C'$ —and we shall obtain the points I, K, J , which will serve to trace the square $H I J K$; and so on to trace as many squares as are wanted.

To measure a line which goes off to the point of distance.

Plate XLVI. Fig. 1. Let $A B$ be the given line, as well as the point $D \frac{1}{3}$. From the point A draw a line to the point P . Divide this line into three equal parts, which will give a . Through this point draw a parallel to $A B$; then, as this parallel stretches to the point $D \frac{1}{3}$, the line goes off to the point of distance. From the point B draw a horizontal line, which will give C on touching $A P$. From the point C as centre, and with a radius equal to $C B$, describe an arc of a circle, till it joins a vertical raised from the same point, which will give E . Join $B E$ by a line, which represents to us $A B$. As

the human figure serves for our measure of $5\frac{1}{2}$ feet, from the point H, the spot where a given figure is placed, draw an indefinite horizontal line. Take the height of the given figure, and bring it from the point I to the point J. From the point P, and through the point J, draw a line, which will give K at its intersection with B C. K C is equal to $5\frac{1}{2}$ feet. By repeating this measure on the line B C, it is found to be $19\frac{1}{2}$ feet; and consequently, A B is equal to $19\frac{1}{2}$ feet.

Remark. A B forms a semi right angle with B C, as going off to the point of distance.

To measure a line which goes off to an accidental point.

Plate XLVI. Fig. 2. Let A B be the given line, as well as the $D\frac{1}{4}$. From the point A draw a line to the point P. Divide it in 4 which will give the point *a*. Through this point draw a parallel to A B, which will give $A\frac{1}{4}$, and shows that the line A B stretches to an accidental point. Then, from the point P as centre, and with an opening of the compass equal to P $D\frac{1}{4}$, describe an arc of a circle, which, at its intersection with the vertical raised from the point P, will give the point $D'\frac{1}{4}$; join by a line the points $A\frac{1}{4}$, $D'\frac{1}{4}$, and through the point B draw a parallel to this line, which will give E on its meeting a vertical line raised from the point C; by measuring B E, we shall know the size of A B. For that purpose, draw from the point H a horizontal line, till it joins the line A P, which will give I; take the height of the given figure, and bring it from I to J. From the point P, and through the point J, draw a line, which will give K. K C is equal to $5\frac{1}{2}$ feet. By repeating this measure upon B E, we shall find that this line is equal to $16\frac{1}{2}$ feet. Then A B is $16\frac{1}{2}$ feet in length.

Plate XLVII. Fig. 1. The line A B being given, supposed to go to one of the points of distance, we propose to draw another line as A C, which will form a right angle with this given line. From the

point A draw a line to the point P, and from the point B an indefinite horizontal line; the intersection of these two lines gives the point O. Take O B and bring it from O to C, join A C by a straight line, this line makes right angles with A B and goes off to the other point of distance.

To construct a square building whose sides go off to the point of distance.

The lines A B, A C, being given, from the points A B, O C, raise indefinite vertical lines; determine at will the height of the tower, as at A'; from this point draw a line to the point P; the meeting of this line with the vertical line, raised from the point O, will give O'; through this point draw a horizontal line, which will give the points B', C'; where it touches the vertical lines raised from the points B, C; join the points A' B', A' C', by lines, thus determining the higher part of the building.

If from the point *a* it is desired to draw parallels to A B, A C, from the point *a* draw a line to the point P; this will give *d*, on joining the vertical line raised from O; through the point *d* draw a horizontal line, which will give the points *b*, *e*; on meeting the verticals raised from the points B, C, draw the lines *a b*, *a e*; they will be parallels to A B, A C, and consequently go off to the same points.

To construct the projecting roof to this same square building.

Let B E, be considered the width of the projection. Take the width B E and repeat it at C', which will give F, also on each side O', thus obtaining the points E', F'; from the point P, and through the points E' F', draw indefinite lines; through the point A' draw a horizontal line, which will give the points G H, on meeting the lines E' P, F' P; join the points E G, F H, by lines which should unite upon the line P A' at the point M. To terminate this roof by making it pass behind the building, from the point H, and through the

point O, draw a line so as to join $F' P$, which will give I; through this point draw a horizontal line till it meets $E' P$, this will give the point E'' , draw the lines $E E''$, $F I$, which must unite upon the line $A' P$, at the point N; these lines pass behind the building; but there are many cases in which it is useless to form entirely the squares of a tower, as often only two sides are seen.

The line $A B$ being given, going off to a point of the horizon out of the picture, it is proposed to draw parallels to it, in perspective, through the points 2, 3, 4, &c.

Fig. 2. The points 2, 3, 4, are placed at equal distances and divide $A H$, into four equal parts. Divide $B H$ into four equal parts which will give the points $2', 3', 4'$, join the corresponding points; the lines $2 2', 3 3', 4 4'$, are parallel to $A B$, and in consequence go off to the same point. To draw parallels to $A B$, through the points 5, 6, 7, $H 5$ is equal to $H 2$; then we must take $H' 2'$ and repeat this quantity from H' to $5'$, then draw a line $5 5'$; it will be the line required. If we wish to draw a line through the point 6, we should remark that $5 6$ is equal to once and a half $H 5$; then we must repeat $H' 5'$ once and a half, and we should have the point $6'$, &c., and so on.

Another method.

Plate XLVIII. Fig. 1. To draw parallels to $A B$ through the points 2, 3, 4, 5, 6. From the point A draw a line $A C$, making any angle with $A H$; take $B H'$, repeat the size from A to M; through the points 2, 3, 4, 5, 6, draw parallels to $H M$, which will give the points E, F, G, I, J; take the quantities $A E$, $E F$, &c. and repeat them from B to $2'$, from $2'$ to $3'$ &c.; then draw the lines $2 2' 3 3'$, $4 4'$ &c.; these lines will be parallel to $A B$, and consequently will go off to the same points.

Another method.

Through a point E, it is proposed to draw a parallel to $C N$.

Fig. 2. From the point E lower a vertical line till it reaches

C N, which will give the point A; from this point draw a line to any part of the horizon—to the point F, for example. From the point B draw a horizontal line which will give O, on touching A F; from the point O raise a vertical line, and from E a line to the point F; the intersection of the lines will give the point O'; from this point draw a horizontal line which will give G; join the points E G by a line, this is parallel in perspective to C N. If through the point I we wish in the same way to draw a parallel to C N, we should draw I F, which would give I'; from this point a horizontal line would give K; I K would be the line required.

To construct the semicircle, work as at Plate XIX. Fig. 1.

Rising and falling ground.

The vanishing lines of the bases of edifices should follow the slope of the ground upon which they repose; that is, if the ground rises they should rise, if it descends they should descend.

The vanishing lines placed horizontally, go off to the horizon, such as the vanishing lines of windows, cornices, &c.

Plate XLIX. In the Fig. 1, the ground rises. The vanishing lines placed horizontally go off to the horizon, whilst the others go off to the point P', the vanishing point of the ground.

Plate L. In this Plate (L.) the ground falls: then the vanishing point of the ground is placed under the horizon.

In these two plates the lines A P', B P', form vanishing scales which serve to indicate the size of the figures.

OF SHADOWS.

We call a body *transparent* when the light passes more or less freely through it, and *opaque* when light will not pass through it.

A luminous body is that which gives light, and communicates it to other bodies.

A luminous ray is a line of light which passes directly from a luminous body.

The rays of the sun or of the moon are considered parallel.

We call *shade* that which is devoid of light, or the difference between an enlightened object and one that is not.

There are two kinds of shade.

The part of a body which is not enlightened, and the shadow of a body projecting over another body or surface; this last is also called reflected shade.

The shade produced by a body is always directed in the way opposite to the light.

The sun is placed in three ways in the surface of a picture—to the right or left of the spectator, before the spectator, or behind the spectator.

The sun being in the plane of the picture.

Find the shadow of a wall, that of a figure being determined at will.

Plate LI. Let B C be the length of the shadow. Join the points A C by a line; this line goes towards the sun—all the solar rays must be drawn parallel to this line. From the point I draw an indefinite horizontal line, and from the point D a parallel to A C; the meeting of these lines gives the point D'; this point is the shade of the point D, and the line I D' is the shade of the line I D. The line D E stretches to a point of the horizon P; from the point P and through the point D' draw a line D' E'; this line will be the boundary of the shadow of the wall.

Remark. Every vanishing line has for a shadow a vanishing line going off to the same point.

To determine the shadow of the gable end of the building.

From the points F H G lower vertical lines, which will give the points O J N; through these points draw horizontal lines, and through

the points $F H G$ parallel lines to $A C$, which will give the points $F' H' G'$. Join the points $F' H'—H' G'$; $O' F' H' G' N$ is the shade of $O F G H N$.

To find the shade of a wall $N. A. B. C. D.$

Plate LII. Fig. 1. From the point C lower a vertical line which will give M ; from this point draw a horizontal line; determine at will the point C' for the shadow of the point C ; join the points $C C'$ by a line. From the point P and through the point C' draw a line $C' D'$, which will be the shade of $C D$. From the point B draw a parallel to $C C'$; this line determines the point B' ; $C' B'$ is the shade of $C B$. From the point B' draw a line to the point P , which meeting a horizontal line, drawn from the point N , gives the point A ; $B' A'$ is the shadow of $A B$, $A' N'$ is the shadow $A N$. The solar rays passing through the window $T O G V$, must determine its form upon the horizontal ground; for that purpose, from the points $T V$ lower vertical lines, which will give the points $I J$; through these points draw indefinite horizontal lines. Through the points $L V$ draw parallels to $C C'$; these lines give the points $V' G'$, on meeting the horizontal lines drawn from the point J ; from the point P and through the points $V' G'$ draw lines, which will give $T' O'$ on their joining the horizontal line drawn from the point I . $L X$ is the shadow.

To determine the shadow of a cylinder.

Fig. 2. Draw a horizontal line from the lower circle, which will give the point B ; from this point raise a vertical line, which will give A ; through the point A draw a parallel to $C C'$, which will give A' ; A' is the shadow of the point A , and $A B$ is the shadow of the height of the cylinder. Take a point as at H , from it lower a vertical line, which will give I ; from this point draw a horizontal line, and from H a parallel to $C C'$, thus we obtain the point H' ; H' is the shadow

of H. From the point H draw a line to the point P, which will give F on meeting the curve; from the point F draw a parallel to C C', and from H' a line to the point P, their intersection gives F'; this point is the shade of F; join the points A' H' F' by a curve, which is the shade of the curve A H F.

To find the shadow of a chimney.

Fig. 3. From the points *a b* draw horizontal lines; from the point *d* draw a line to the point P, and from the point *c* draw a horizontal line, which will give *e*; from the points *e d* draw parallels to C C', these meeting the horizontal lines, drawn from the points *a b*, will give *d' e'*; join these points. *a d' e' b* is the shade of the chimney.

To find the shade of a projection of a roof.

Plate LIII. From the point L lower a vertical line; mark the extent of the shadow as at the point J; join the points J J' by a line, which is supposed to go to the sun. From the point P and through the point J', draw a line J' K', this line is the shade of the line J K.

To find the shadow cast upon a window by the top, or the line A B.

From the point A draw a parallel to J J', which will give the point A'; from the point P and through the point A', draw a line A' B'; this is the shadow required.

To find the shadow thrown by the door C D E upon the wall.

From the point E draw a horizontal line, which will give the point F; from this point raise a vertical line, and from the point D draw a parallel to J J'; this will give D'; join the points D' C. C D' is the shadow of C D; D' E F is the shadow of D E.

To find the shadow of a figure G H.

From the point H draw a horizontal line, which will give I''; from

this point raise a vertical line, and from the point G a parallel to I I', which will give G'. H I' G' is the shadow of the figure.

To find the shadow of a stick O M.

From the point O lower a vertical line, and from the point M draw a parallel to J J', which gives M'. O M' is the shadow of O M. The more a surface is enlightened the more vigorous will be the shadows cast upon its surface. The less a surface is enlightened the weaker will be the shadows. The reflected shade is stronger or weaker according as the body producing it is near or distant. When a strong light is thrown upon a body, this body reflects it on the objects which surround it; these objects are then said to be enlightened by reflection.

The more brilliant a light is so much more brilliant will be the reflection from it.

The sun being before the spectator.

Plate LIV. The shadow of a figure A B being determined, it is proposed to find the shadow thrown on the ground by the wall D E.

From the point C and through the point B draw a line to the horizon, which will give the point T; from this point raise an indefinite vertical line. From the point C and through the point A at the head of the given figure, draw a line, which will give the point S on touching the vertical line raised from the point T. The point S is the focus of the light, and the point T is called the base of the vertical line lowered from the sun. From the point T and through the point E draw an indefinite line. From the point S and through the point D draw a line, which will give F at its intersection with T E; F is the shade of D, as this wall goes to the point P; from this point and through the point F draw a line—this will indicate the shadow of the wall.

To find the shade of a rectangular stone M, H, G, I.

From the point T, and through the point I, draw a line; from the point S, and through the point G draw another; their intersection gives J. I J is the shade of I G. As G H is horizontal from the point J, draw a horizontal line to meet a line drawn from S through H. J K is the shadow of G H. As H M goes towards the point P, from this point draw a line to the point K; from the point S, and through the point N, draw a line which will give L, on touching K P. K L is the shadow of H M. From the point L draw a line to the point T, &c.

To find on a wall the shadow of a beam, N, O, U, X.

As this wall goes off to the point P, from this point raise a vertical, and from the point S a horizontal line; the intersection of these two lines gives the point T'. From this point, and through the points N, X, draw lines which will give the points R, V; join these points by a line which must go off to the point P.

To find the shadow of a wall facing the spectator upon a vanishing wall, and upon a horizontal ground.

Plate LV. From the point I, and through the point A, draw a line which will give A'; through the point A' draw a horizontal line A' A''; A' A'' is the shadow of the wall in front.

The solar rays, passing through the door-way, must determine the form of it on the horizontal ground. From the point I, and through the points K, L, draw indefinite lines; from the point S, and through the point M, draw a line which will give F, when it touches I K; from the point F draw a horizontal line F O.

To find the shadow of a building, and to find on its roof the shadow of a pole.

Plate LVI. The point S being given, from it lower a vertical line

to the horizon which will give I; from this point, and through the points K, J', J, draw indefinite lines; from the point S, and through the points B, A, draw lines which will give the points A', B', join these points by a line. As the line A C is horizontal from the point A', draw a horizontal line A' C'. For the shadow of the stick N M, prolong J' K as far as the horizon, which will give P; from this point raise a vertical line and prolong the line A B, which will give F; from the point F draw a horizontal line, so as to meet the vertical S I, which will give I'; from this point, and through the point N, draw a line as well as from the point S, and through the point M. The intersection of these lines gives M'; N, M', is the shadow of the line M N.

The sun being behind the spectator.

Plate LVII. It is proposed to find the shadow of a building, F, H, E, D, G, that of a figure A B being determined. Let B C be the shadow of A B. Prolong the central line of the shadow B C as far as the horizon, which will give the point I; from the point A, summit of the given figure, and through the point C, draw a line to meet a vertical line, lowered from the point I, which gives the point N: this point is, as usual, as much below the horizon, as the sun is above it. It is called the vanishing point of the solar rays. From the point E lower a vertical line which will give T, on meeting the line F G; from the points F, T, G, draw lines to the point I, and from the points H, E, D, lines to the point N, which will give the points H', E', D'; draw the lines H' E', D'; F, H', E', D', G, is the shadow of F, H, E, D, G. To terminate the shadow draw a horizontal line from D'.

To find on a roof the shadow of a stick E'' G'.

From the points P I raise indefinite vertical lines; prolong the line H E which will give the point F; from the point F draw a horizontal line which will give I'; from this point draw a line to the

point E'' , and from the point G' draw a line to the point N , which will give G'' . $E'' G''$ is the shadow of $E' G'$.

To find the shadow cast by a door on a wall.

Plate LVIII. The points $N T$ being given, from the point B , draw a line to the point T , which will give the point B' on meeting the wall; from this point raise a vertical line, and from the point A draw a line to the point N ; the intersection of these two lines gives the point A' , join this point with the point $C B$. $B' A'$ is the shadow of $B A$. $A' C$ is the shadow of $A C$.

To find the shadow of a plank D E, F O, placed upon a wall.

From the point P , vanishing point of this wall, lower a vertical line, and from the point N draw a horizontal line, which will give T' ; from the points $D E$ draw lines to the point T' , and from the points $E F$ draw lines to the point N ; the intersection of these lines gives the points $E' F'$, which must be joined by a line which ought to go off to the same point as $E F$. $D E' F' O$, is the shadow of $D E F O$.

To determine the part in shadow of an arched door-way and door.

Take several points upon the curve, such as $J L$; from these points draw lines to the point P , which will give the points $O L'$, join the point P with the point N , this line is parallel to the direction of the luminous rays; from the points $O L'$, draw parallels to $P N$, and through the points $J L$, lines to the point N , which will give the points $M H$; through these points draw the curve X, M, H . To determine the shadow the arch-way throws upon itself; take several points upon the curve; from these points D , for example, draw a line parallel to $P N$, which will give $D D'$; from the point D' draw a line to the point P , from the point D , a line to the point N , which will

give the point d ; in the same way obtain several points and draw the curve required.

Plate LX. The wall $A O$ cannot be enlightened by the sun, because this last appears between the wall and its vanishing point. If we suppose this wall prolonged to the horizon, we find the sun would be behind it.

A wall cannot be enlightened except when the sun appears to pass beyond its vanishing point.

The under part of a horizontal plane such as the under side of a cornice can never be illuminated by the sun's rays, low as it may be, because the vanishing lines of a horizontal plane go off to the horizon, whilst the sun is always above the horizon.

Of shadows cast by bodies illumined by artificial light, such as lamps, &c.

The rays of artificial light diverge from the centre where the light is strongest.

To find the shadow of a table $A B D$, the focus of the light being at the point F .

Plate LXI. From the point F , lower a vertical to the table which will give the point P ; from this point draw a horizontal line which will give the point C , on the table joining the wall; from the point C , raise a vertical line, and from the point F draw a horizontal line, which will give the point P' ; base of the perpendicular line lowered from the light upon the wall; from this point, and through the point A , draw a line which will give a ; from this point draw a horizontal to meet a line from F , through B , which will give b : A, a, b , is the shadow of $A B$. As $B D$ goes off to the point P , from the point b , draw a line to this point and till it meets a line drawn from the point F , and through the point D , which gives d ; $b d$ is the shadow of $B D$; draw a horizontal line from the point d to the wall, and the shadow will be clearly defined.

To indicate the shadow thrown on the wall by the figure E F.

From the point C lower a vertical line which will give O; from this point draw a horizontal line, and from the point P, lower a vertical line (as before), which will give P''; from this point and through the point F, draw a line which will give f; from this point raise a vertical line so as to meet a line drawn from the point F and through the point E, which will terminate the shadow at the point e.

To find the shadow cast by a door I, H, G.

From the point P'' and through the point G, draw a line which will give the point o; from this point raise a vertical line as far as one drawn from the point F and through the point h; join this point with the point I; h I is the shadow of H I; h o G is the shadow of H G.

To find on a door the shadow of the door way.

From the point P'' and through the point i, draw a line which will give L; from this point raise a vertical line which will give M; join the points M, K; i L M K is the part in shade.

To find upon a window the part overshadowed by the side R V.

Prolong the line Y R, as far as a vertical line raised from the point P'. which will give N; from this point draw a horizontal line and from the point F raise a vertical line which will give the point P''' ; from this and through the point R, draw a line which will give S; from this point lower a vertical line, &c.

To find the shadow of a stick, Z X.

From the point P'' draw a line to the point P, which will give u; from this point raise a vertical line to join a line drawn from the

point F to the point P, which will give the point P''''; from this point and through the point Z, draw a line till it meets a line drawn from the point F, and through the point X, which will give z'.

It must be observed, that P, P', P'', P''', P'''' are the points of the termination of the light on the surfaces where it is proposed to find the shadows required.

To find the shadows cast by a beam on the ceiling. The focus of the light being at the point F.

From the point P draw a horizontal line which will give B; from this point lower a vertical line, and from the point F draw a horizontal line which will give the point P'; from the point P' and through the point A draw a line which will give a; from this point draw a horizontal line w; join the points w' A'. The line A w should go to the point P''.

To find the shadow cast by a plank c, D, E, o.

From the point P'' and through the points c, o, draw indefinite lines; from the point F and through the points D, E, draw lines which will give the points d, e; join these points by a straight line which must go off to the same vanishing point as D E.

To find the shadow cast by a door upon a wall, G H I.

From the point P, lower a vertical line which will give M; from this point draw a horizontal line, and from the point F lower a vertical line which will give P'''; from this point and through the point G draw a line which will give g; from this point raise a vertical till it reaches a line drawn from the point F and through the point H,

which will give h . G, g, h , is the shadow of $G H$; from the point h , draw a line to the vanishing point of the line $H I$, which will give J ; join this point with the point I . h, J, I , is the shadow of $H I$.

REFLECTIONS OF OBJECTS IN THE WATER.

If the water be perfectly still, then the reflection will be very distinct, but if it is agitated by the current or wind, the reflection will appear broken or wavy.

Every object is repeated or reflected by making the angle of reflection equal to the angle of incidence.

The reflection of any object appears in the water at an equal distance to the object above the water.

The reflection is always equal to the object which has produced it.

To determine the reflection of the line A B.

Plate LXIII. As the line $A B$ is vertical, it may be prolonged; take the size $A B$ and repeat it from A to B' ; $A B'$ is the reflection of $A B$.

To determine the reflection of the line C D.

As the line $C D$ is not perpendicular from the point D , lower an indefinite vertical line; take the size $D E$ and bring it from E to D' ; join the point C, D' by a line which is the reflection of $C D$.

To determine the reflection of steps.

Prolong the line $G O$; take the sizes $O F, F' G$, and mark them at $O F'$; &c.; from the point P and through the points $F' G'$ draw indefinite lines; from the points H, I , lower vertical lines which will give the points $H' I'$; O', H', J', I', G' , is the reflection of O, H, J, I, G ; through the points $H' I'$ draw horizontal lines.

To determine the reflection of an arch of a bridge.

Plate LXIV. From the point C as centre, and with a radius equal to C A, draw a semi-circle as A E' B, which is the reflection of the semicircle A, E, B; from the points A, C, draw lines to the point P; from A' draw a horizontal line which will give the point C'; from the point C' as centre, and with a radius equal to C' A', describe a semi-circle A' M, which is the reflection of A' N.

To determine the reflection of a buttress.

Plate LXV. Fig. 1. From the point C lower an indefinite vertical line; take the size C A and bring it from C to A'; join the the points B, A', by a line which is the reflection of B A; from the point E lower a vertical line, and from the point A', draw a horizontal line, which will give the point E; join this point with the point F; E', F is the reflection of E F.

To find the reflection of the water spout, Fig. 2.

Fig. 2. From the point H, lower an indefinite vertical line; take the sizes O H, H G, and bring them from O to H' G'; from the point P, and through the points H', G', draw lines so as to meet a vertical line lowered from the point I, which will give I'; from this point draw a horizontal line which will give J', on meeting a vertical line lowered from the point J, &c.

To find the reflection of a building, D, A, E.

Plate LXVI. From the points d, a, e, lower indefinite vertical lines; from the point P and through the point a, draw a line which will give the point B; from this point lower a vertical line down to the level of the water, which will give B'; from this point draw a line to the point P, it will give the point a'; take the size a' A, and mark

it from a' to A' ; from the point A' draw a horizontal line $A'E'$ and a line to the point P , this will give D' and terminates the reflection of the building.

For the reflection of the roof.

From the point M , lower an indefinite vertical line; draw the lines ED , $E'D'$, which will give the points O , O' ; take the size OM and bring it from O' to M' ; draw the lines $M'E'$, $M'A'$.

To find the reflection of the sun or moon on the water.

From the centre of the sun or moon lower an indefinite vertical line; mark the distance above the horizon and the same distance below will be the place of the reflection. Thus take the size IS and bring it from I to S' .

REFLECTIONS OF OBJECTS IN GLASSES OR MIRRORS.

The place of the reflection of an object in a looking-glass is found in the same way as that of an object in the water.

In a glass AA' to reflect a floor of square flags.

Plate LXVII. Fig. 0. We must continue the rows of flags as many times in the mirror as in the interior of the room.

To reflect the flags in the glass BB' .

Take the sizes OA , AJ , &c. and bring them from OJ' to $J'I'$; from the point P , and through the points $I'J'$, draw lines as far as the side BB' of the glass; prolong also as far as the same side the horizontal lines of as many of the rows as can be contained in the mirror.

The point M is reflected at the point M' ,

The point O at the point O' ,

The point X at the point X' .

To find in the mirror $A A'$ the reflection of the point D .

From the point D draw a line to the point P , the intersection of this line with the surface of the glass will give O ; beginning from this point mark two equal sizes as at the points $I J$; from the point J draw a line to the point P ; from the point D , and through the point I , draw a line which will give E ; from this point draw a horizontal line, which will give D' ; this is the reflection of the point D .

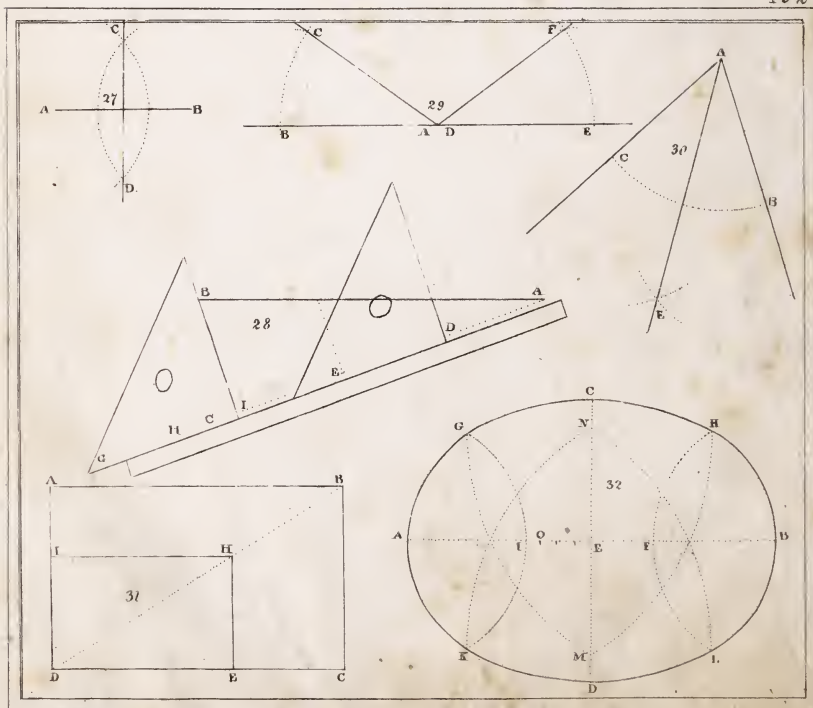
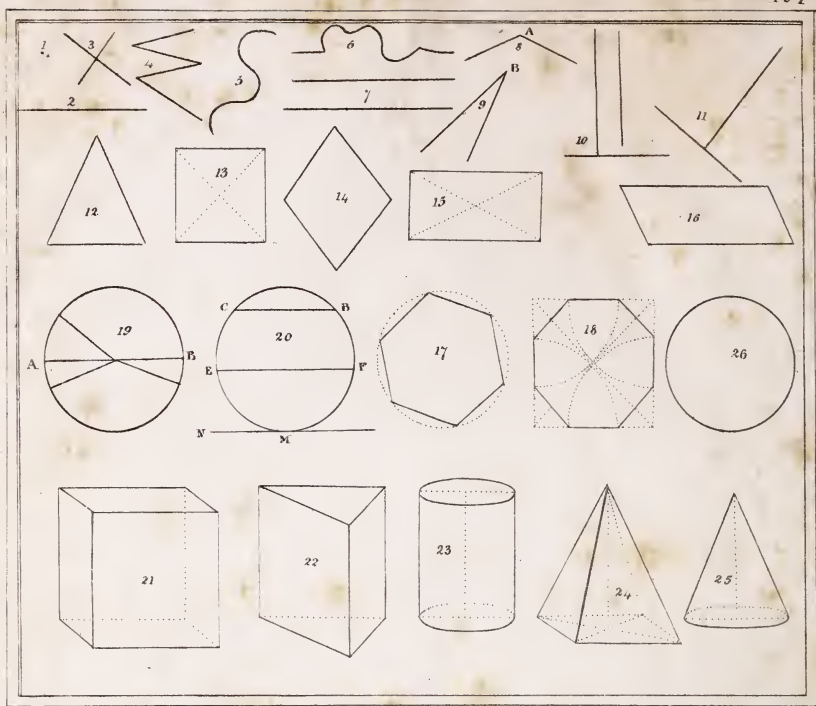
FINIS

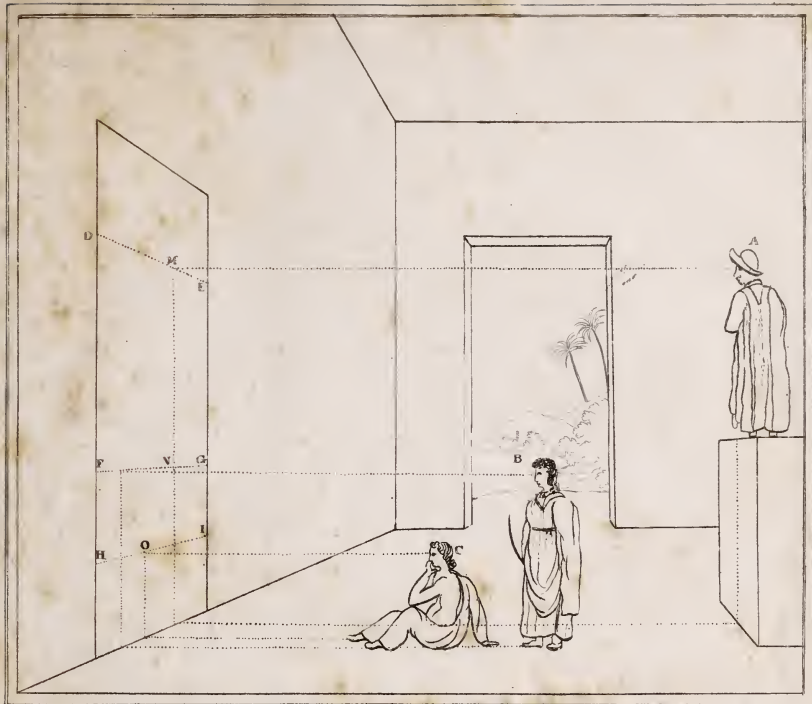






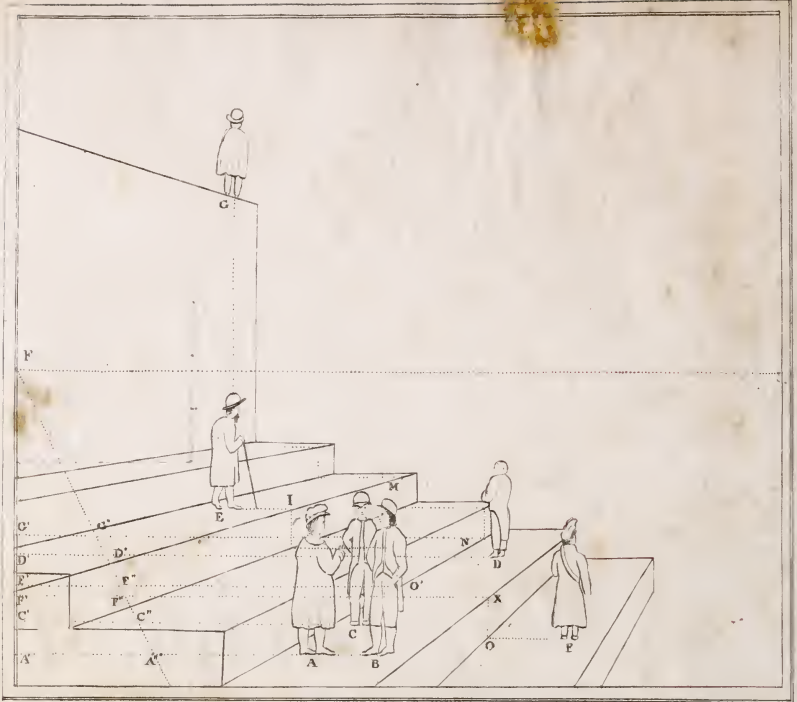










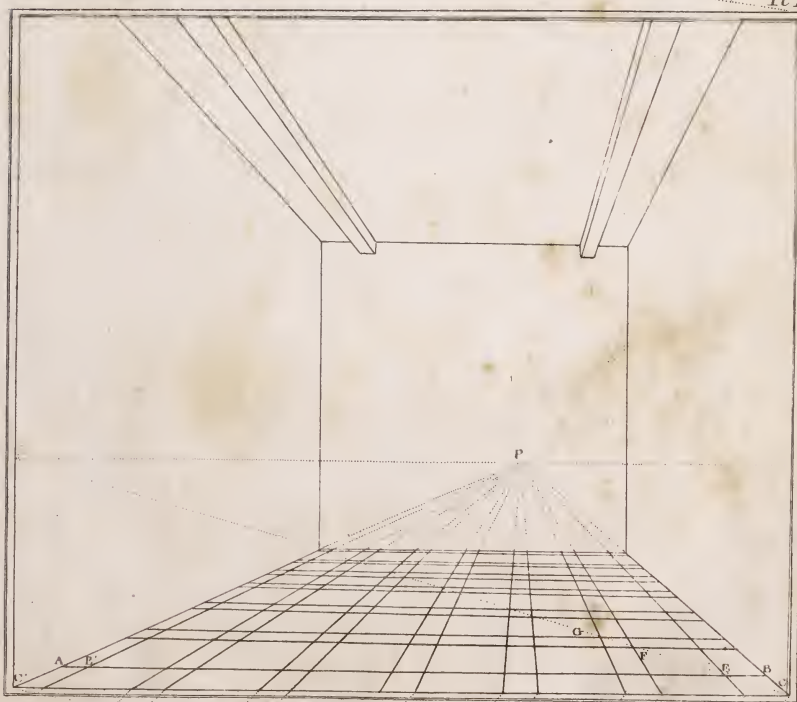
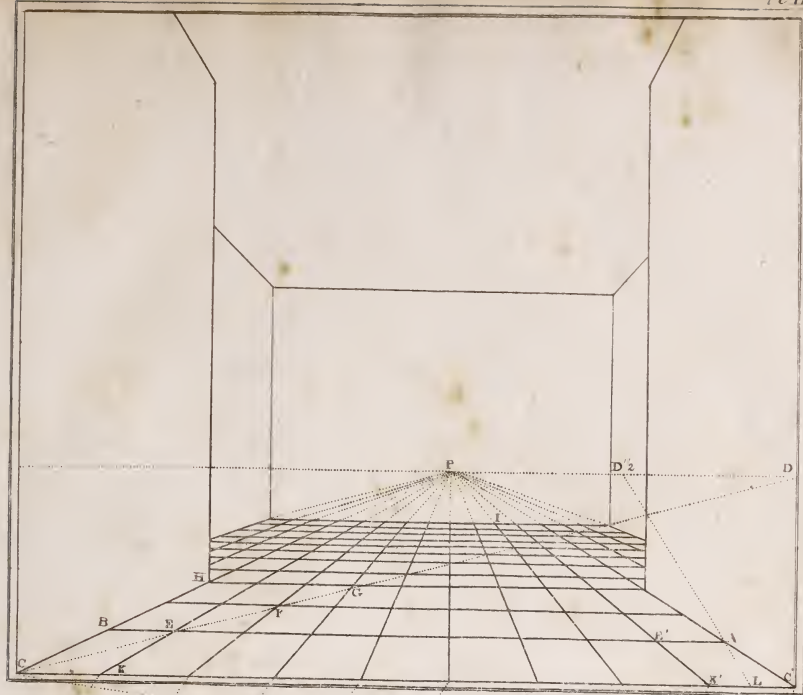






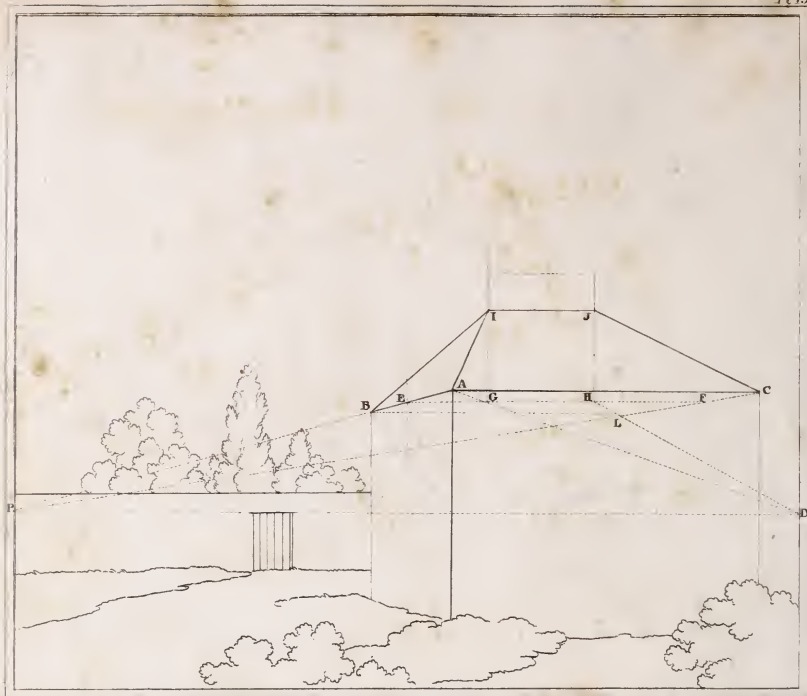








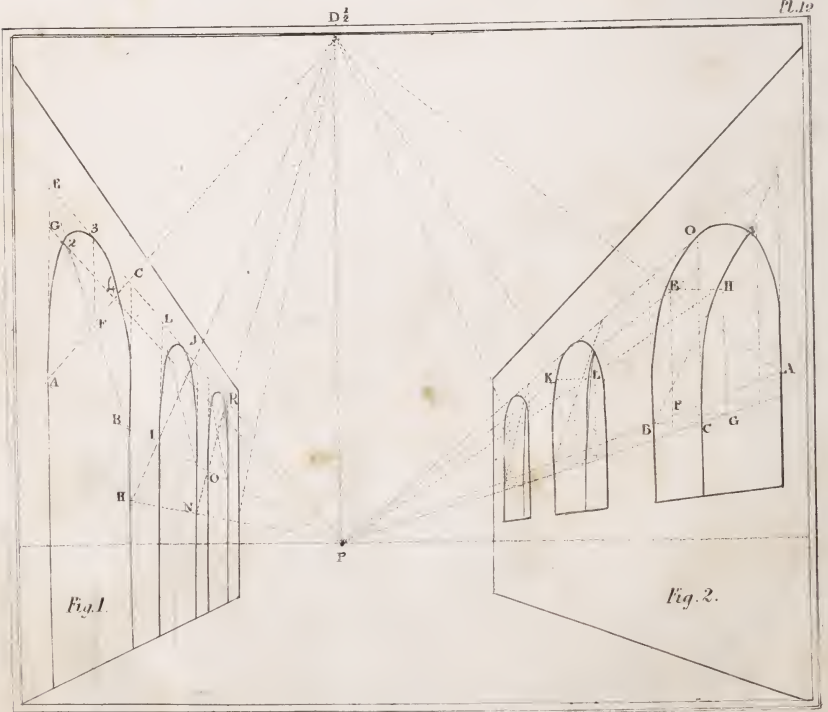
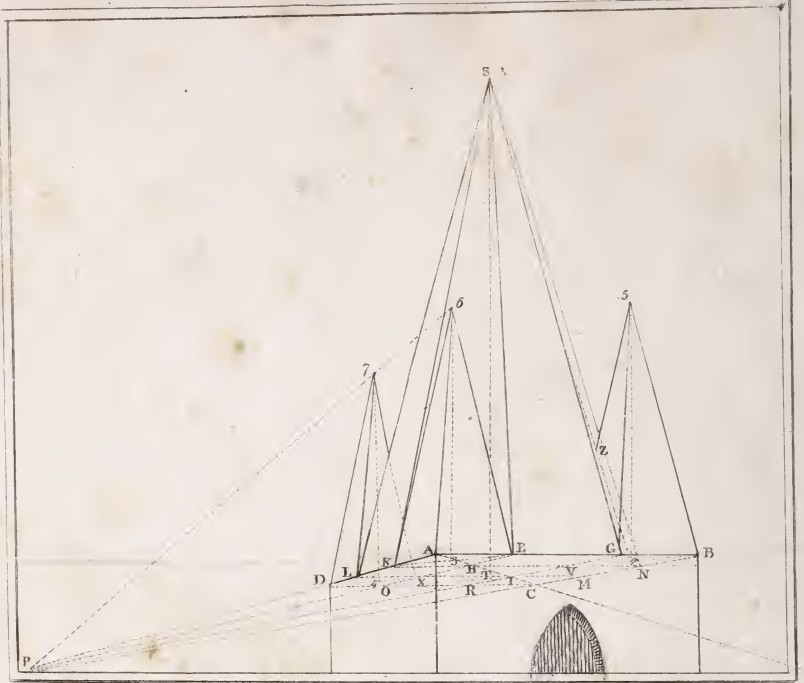


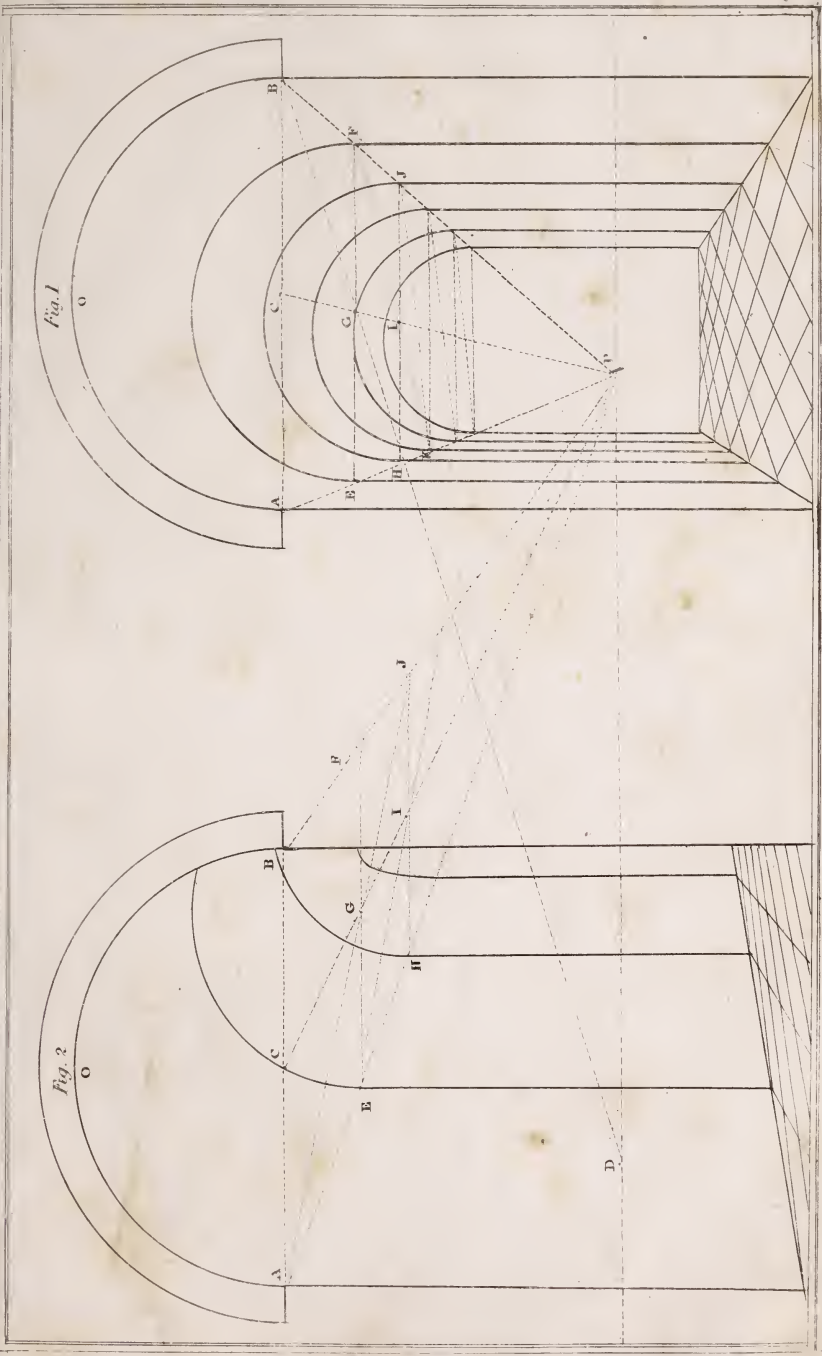






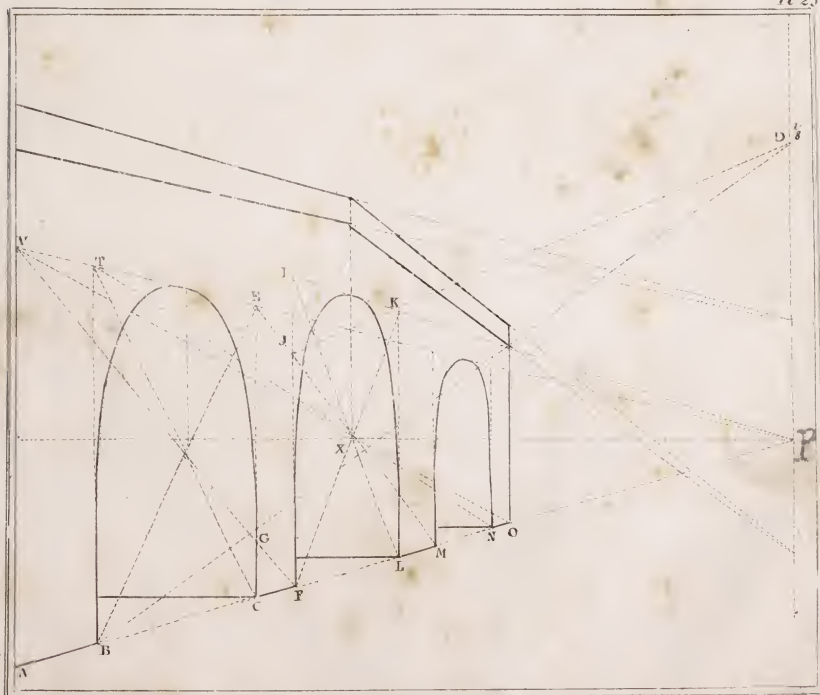
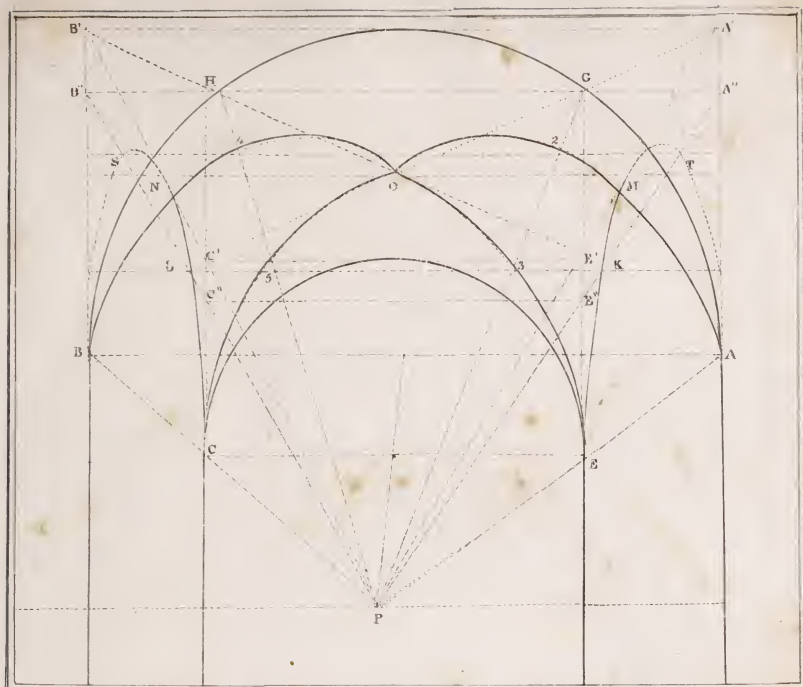






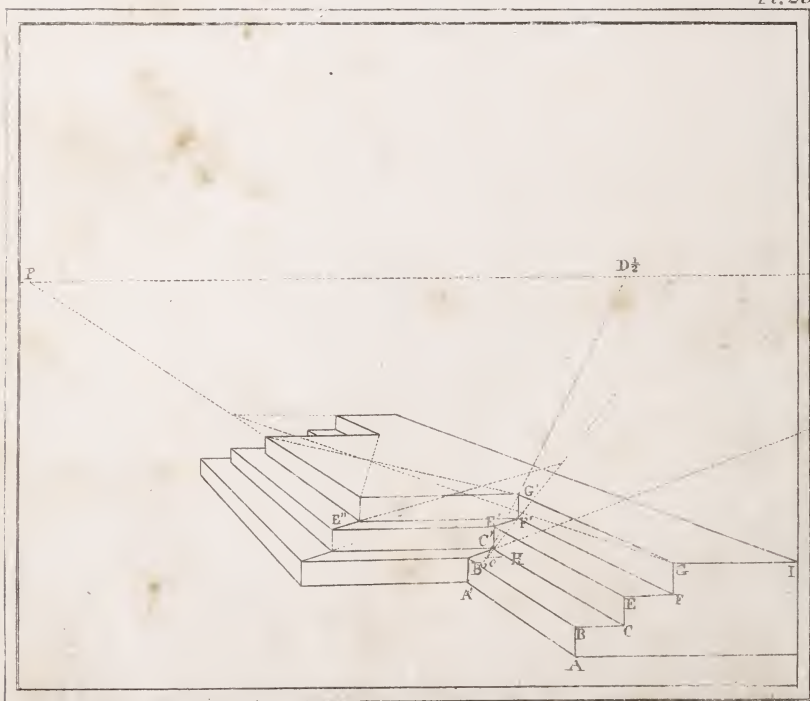
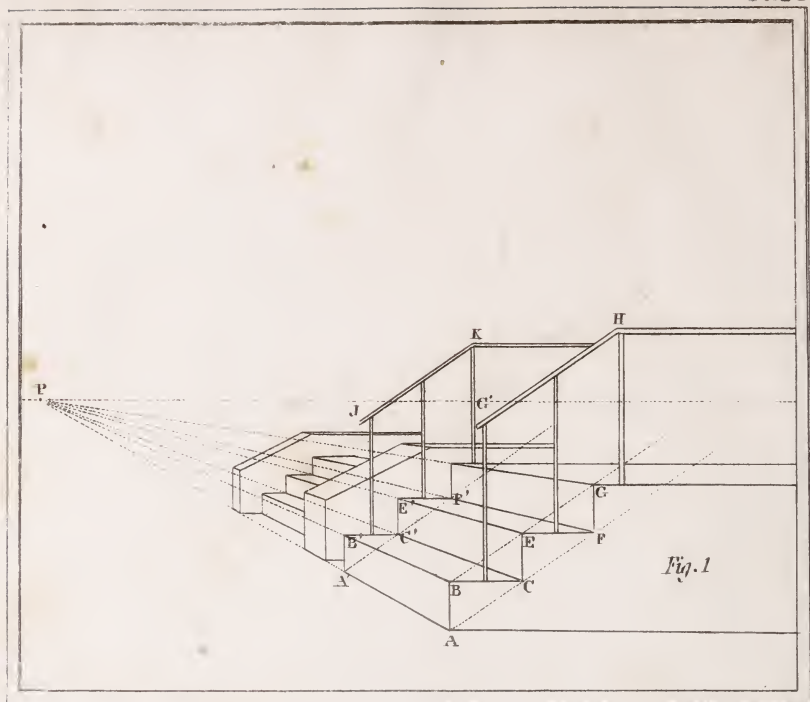


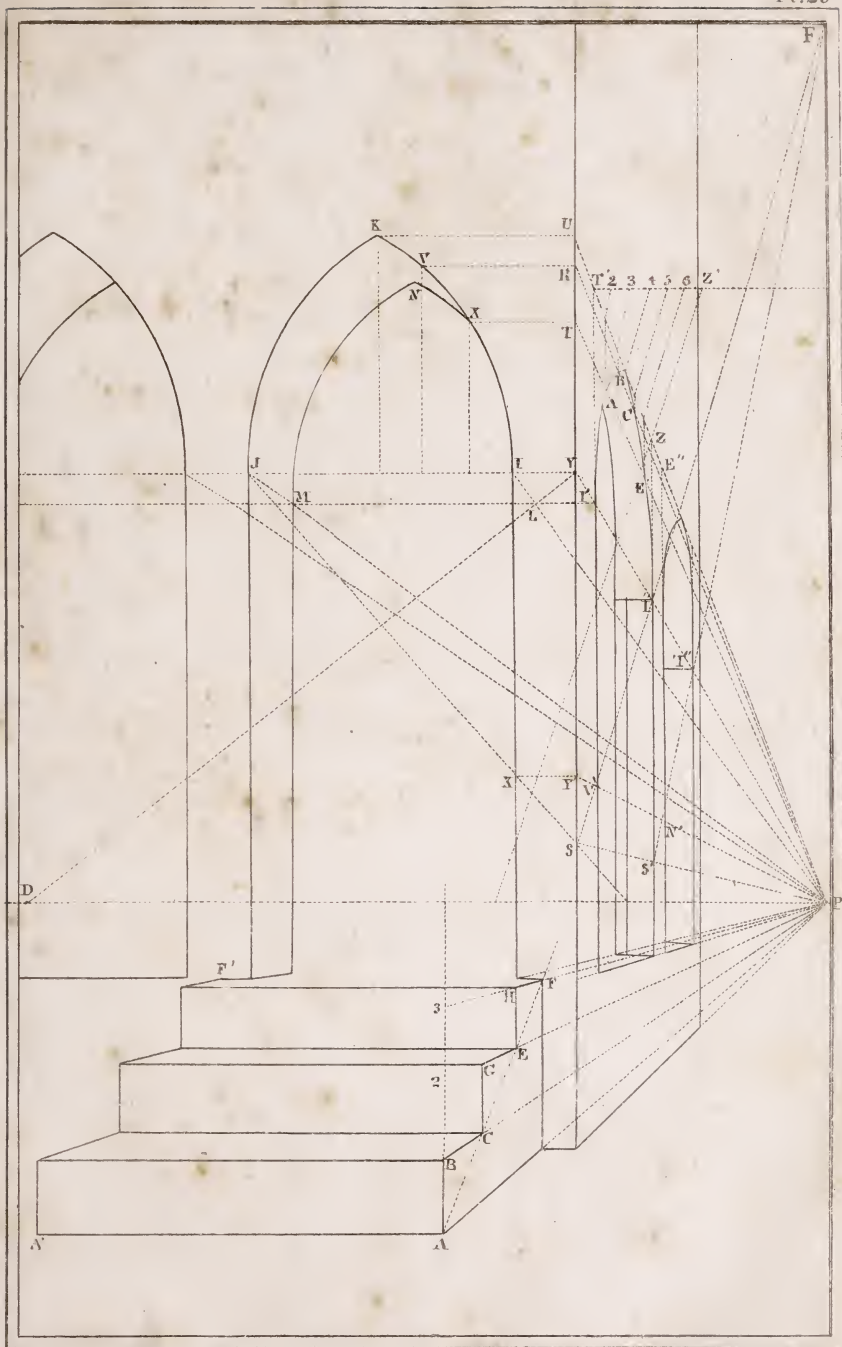






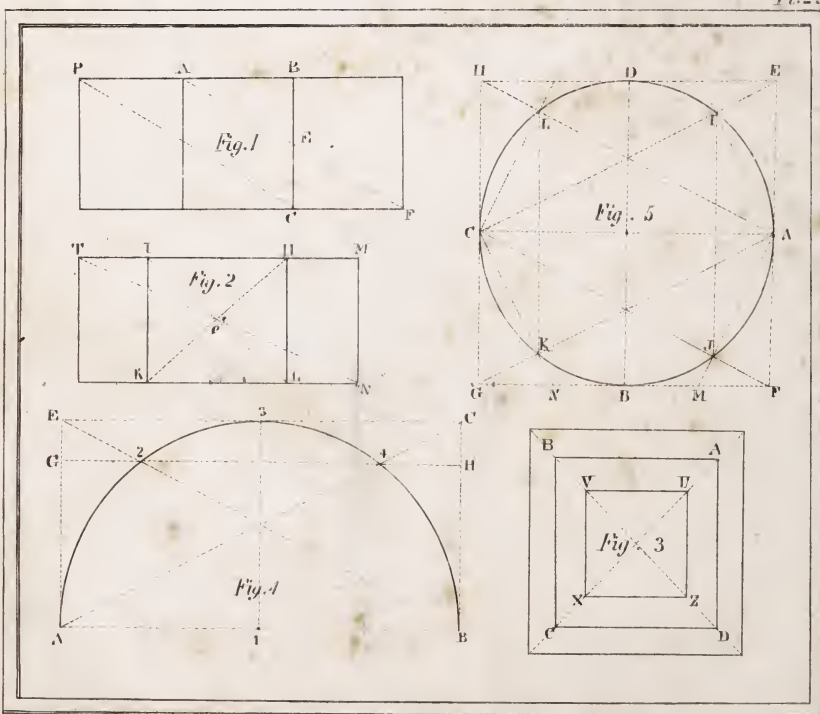
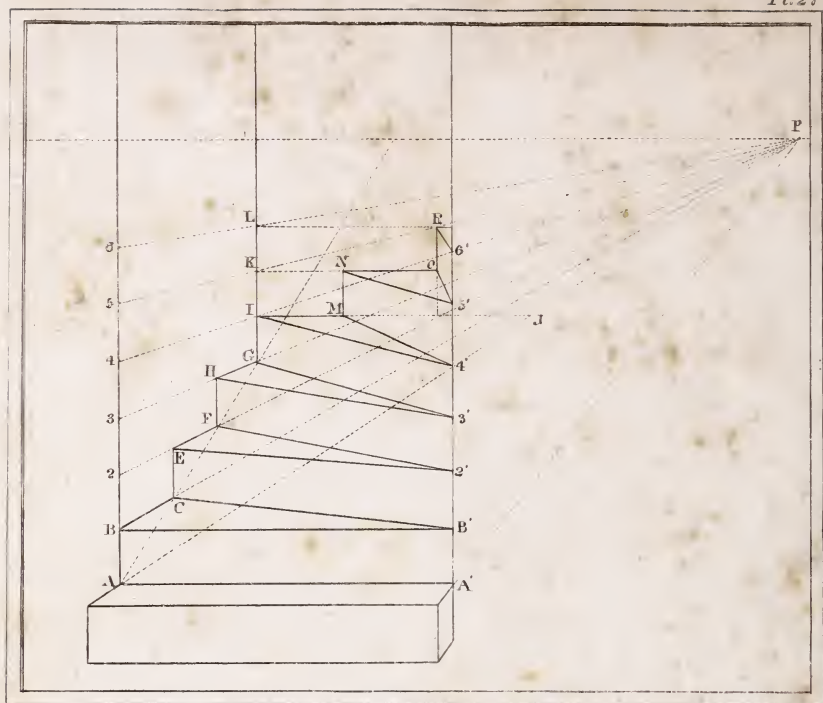


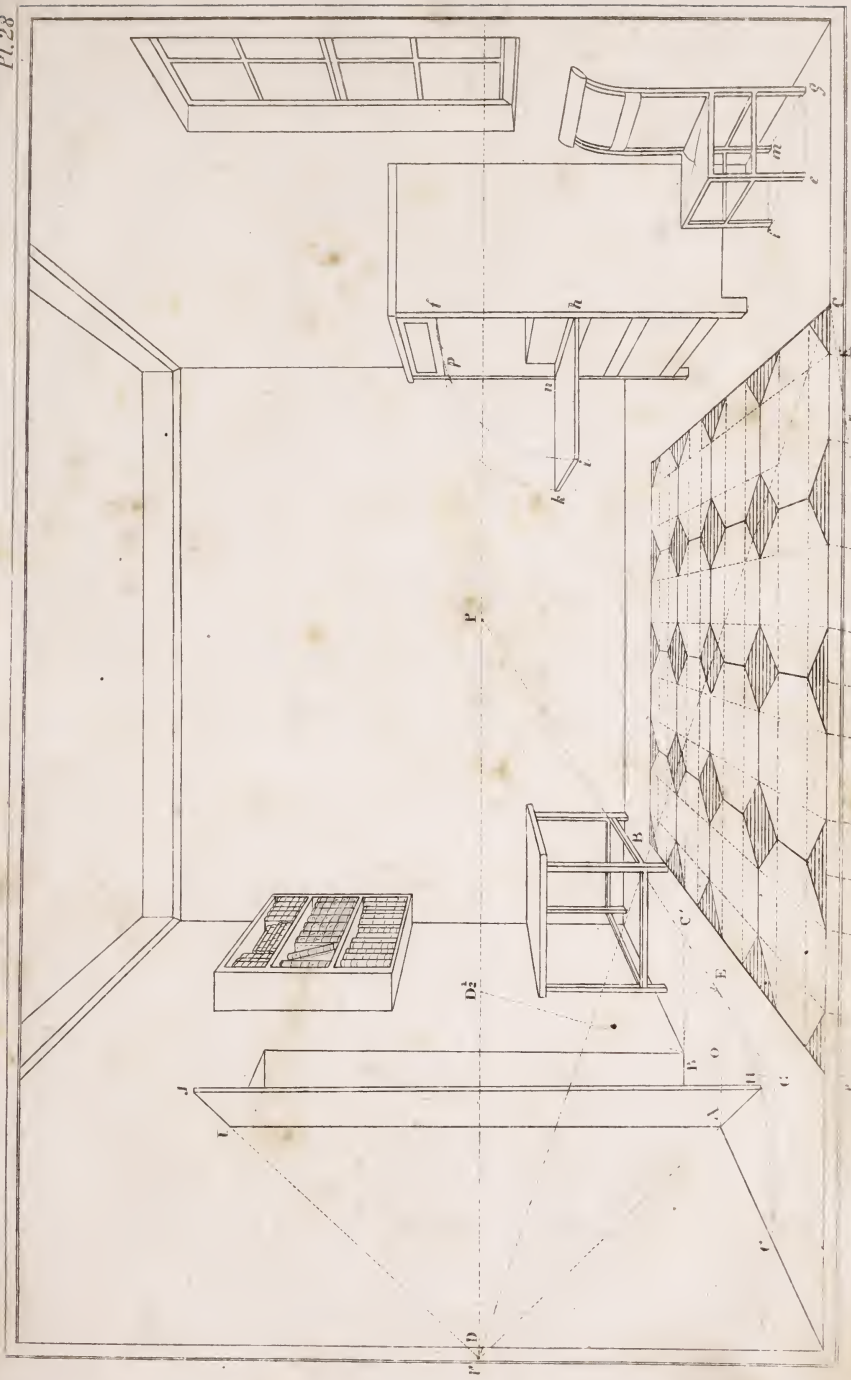






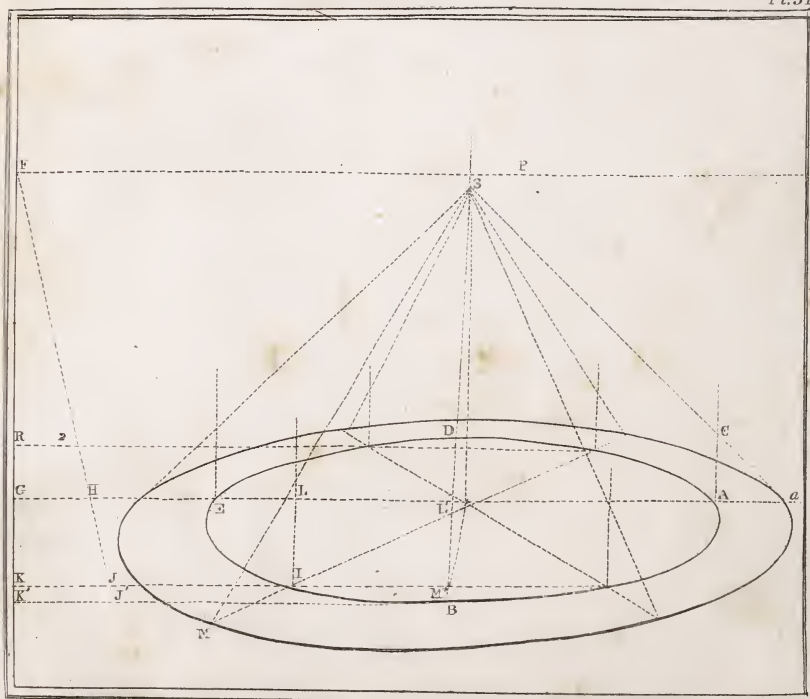
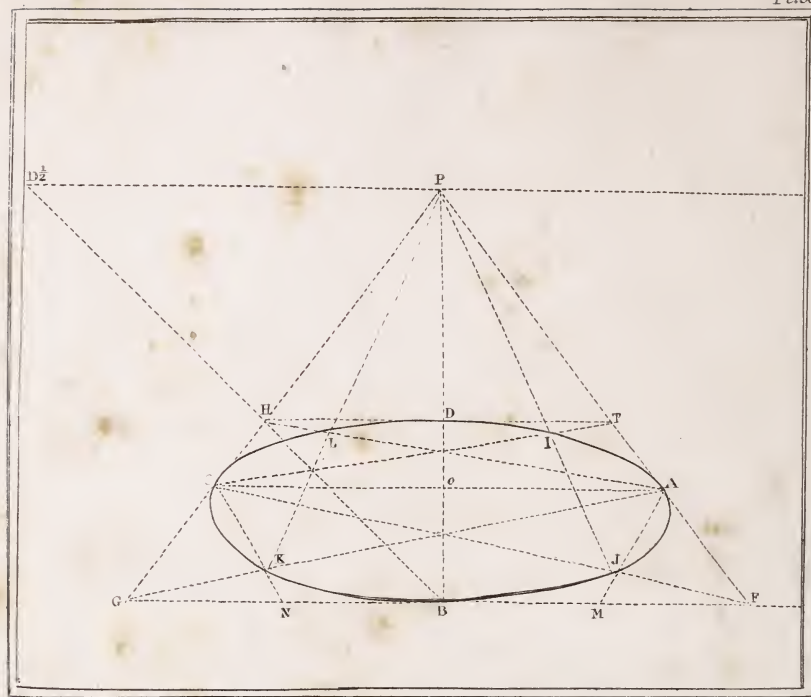


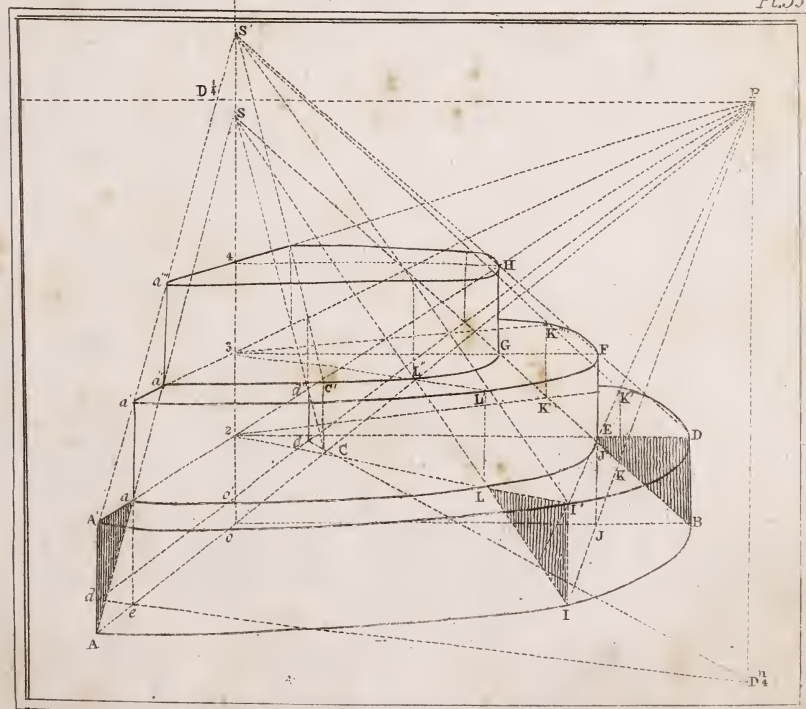
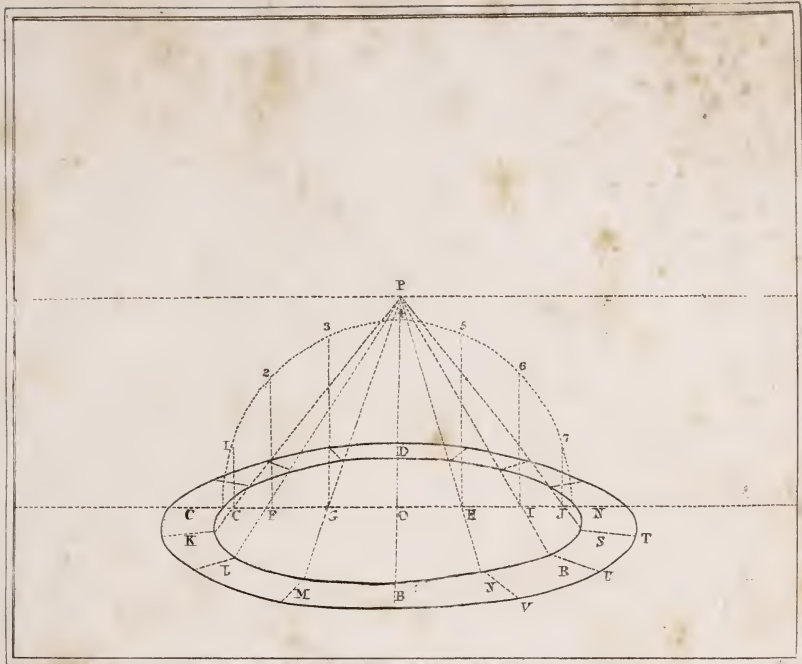










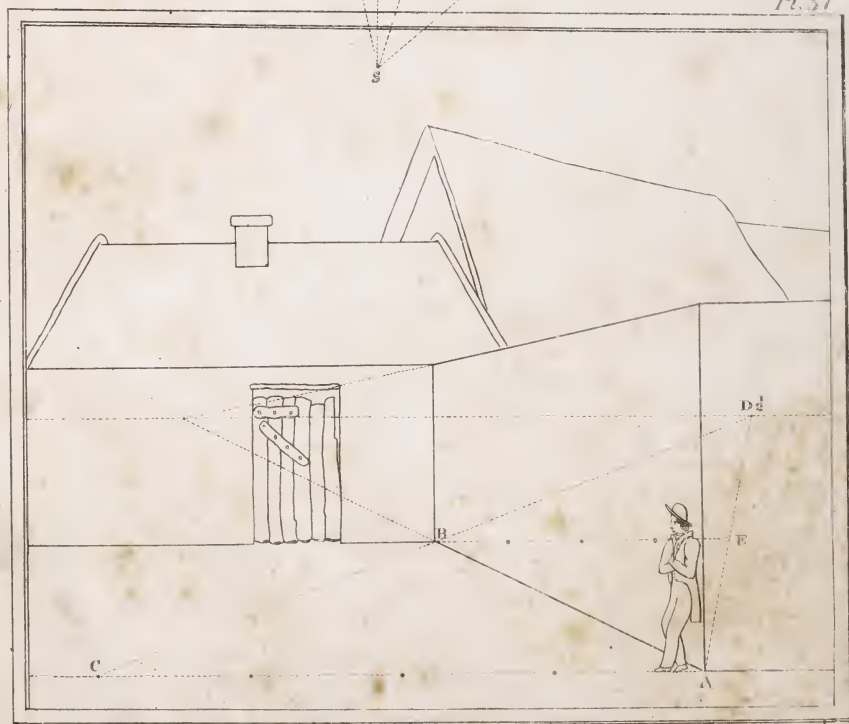
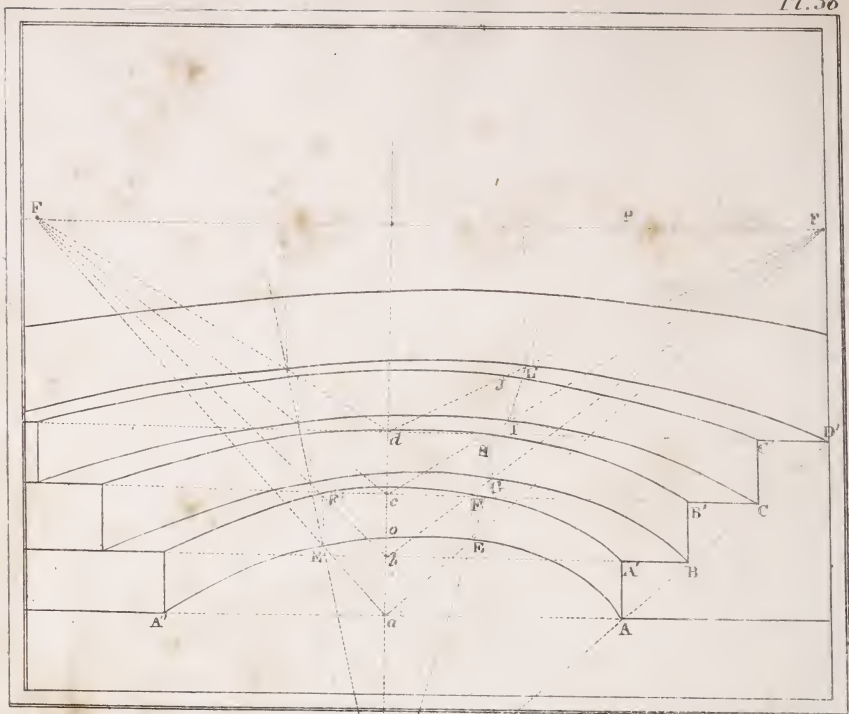


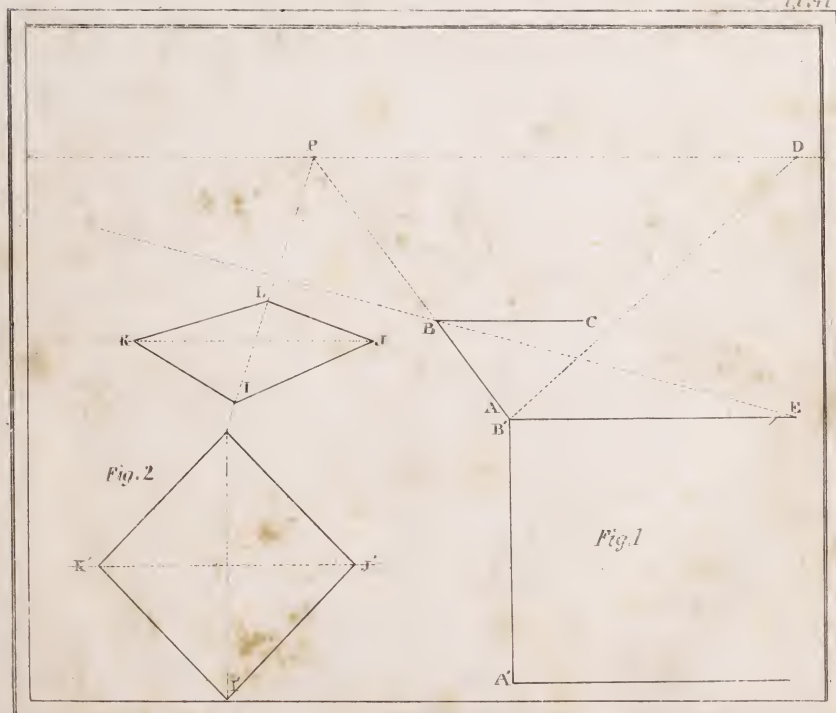
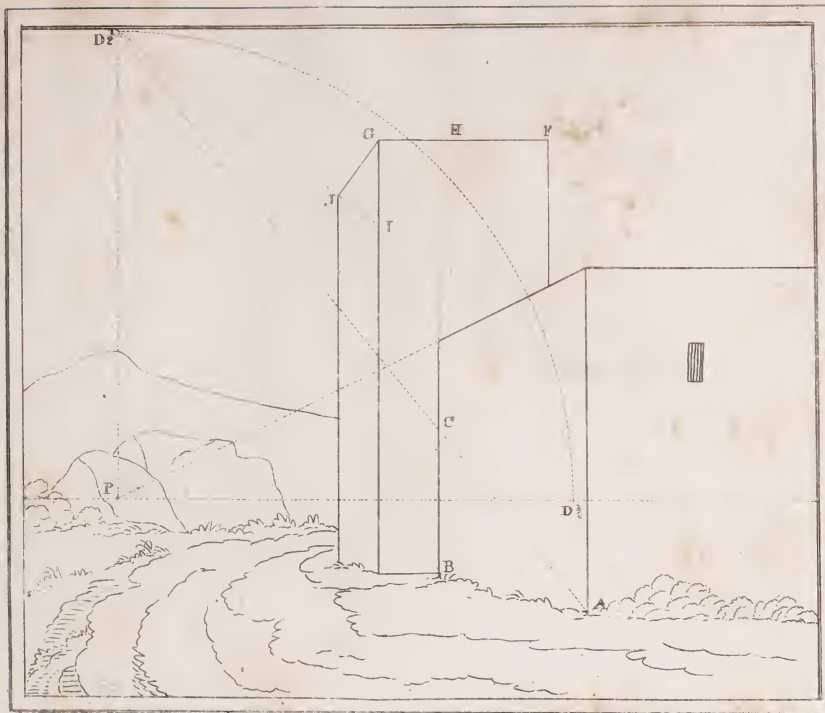
















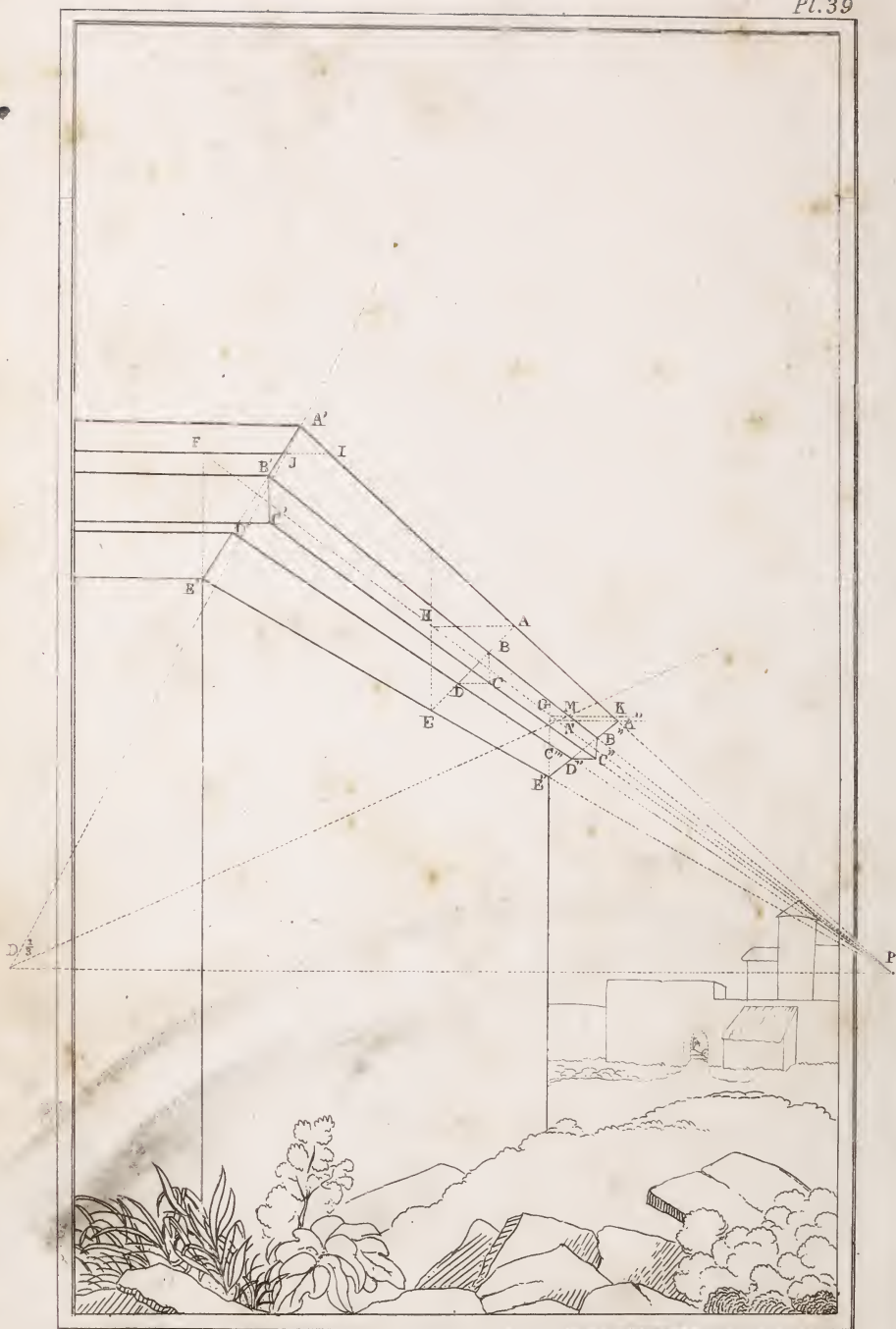


Fig 2

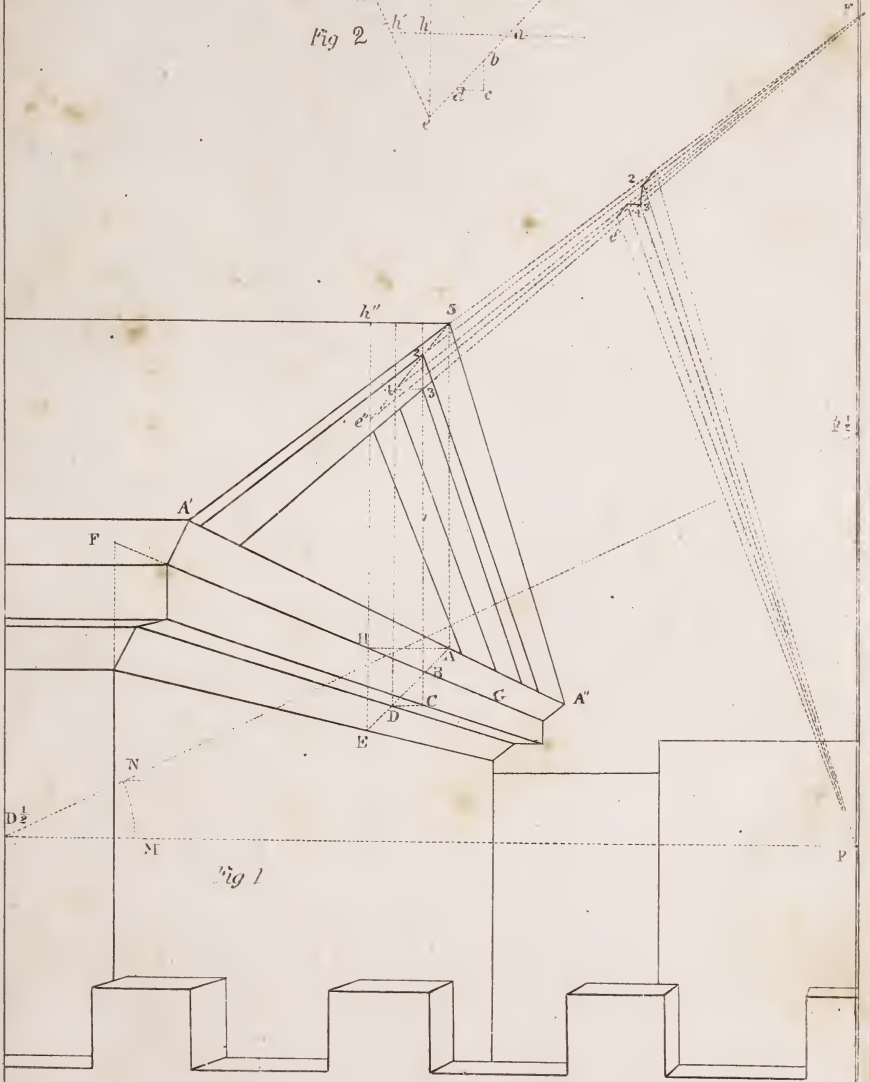
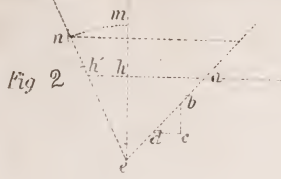
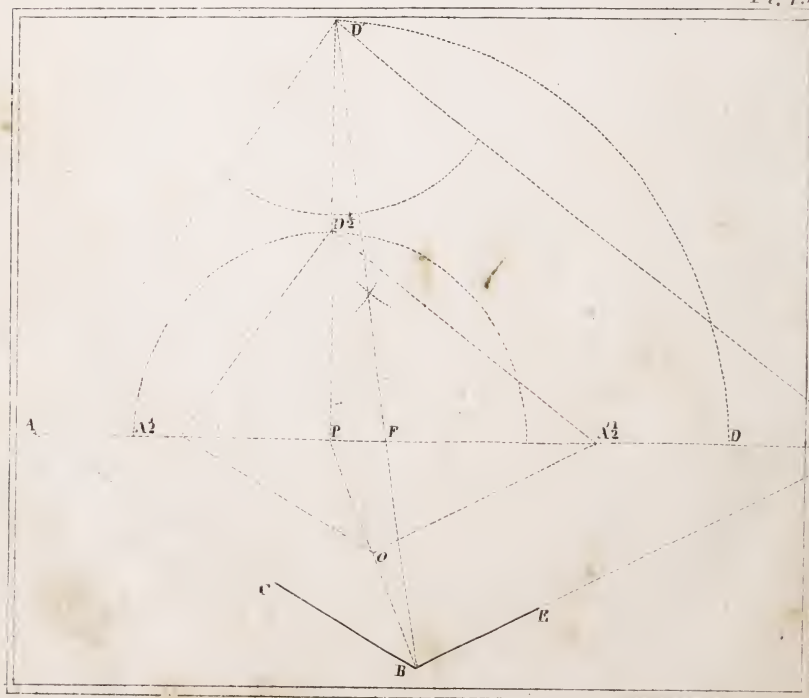
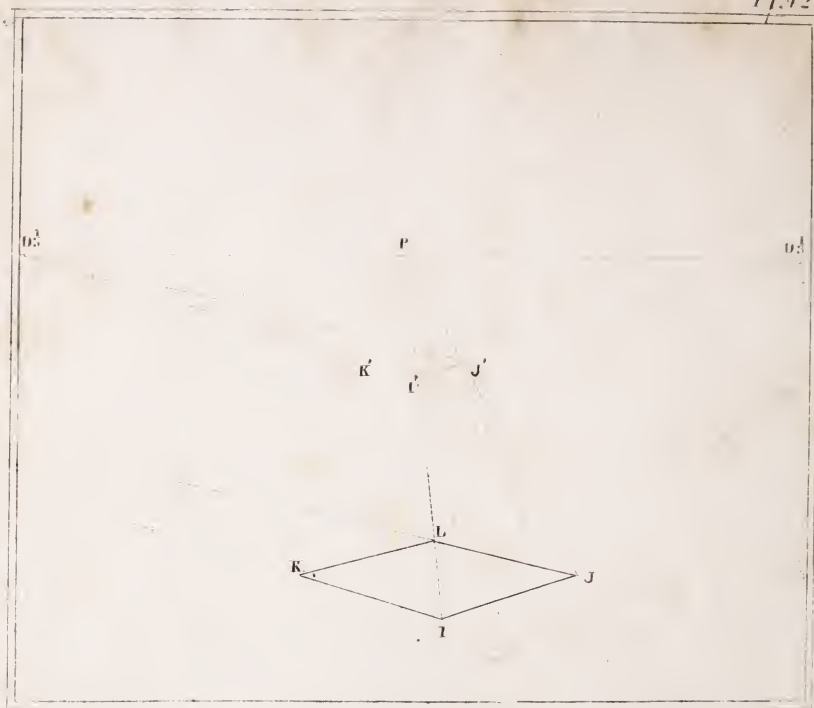


Fig 1

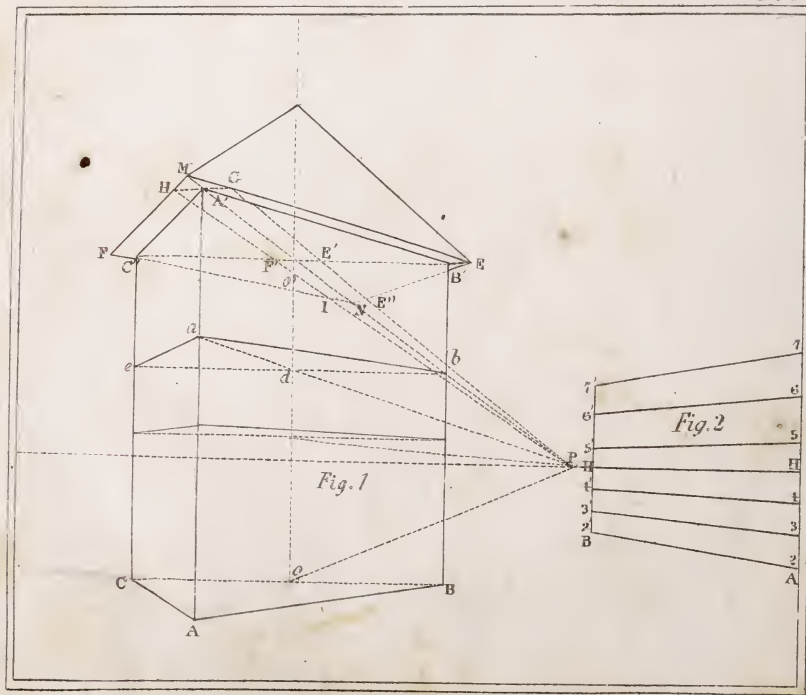
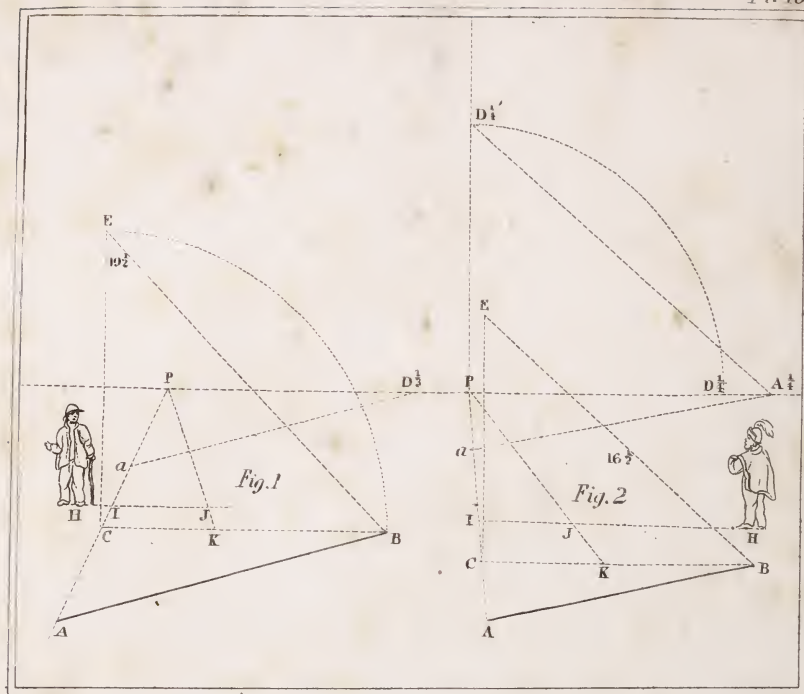


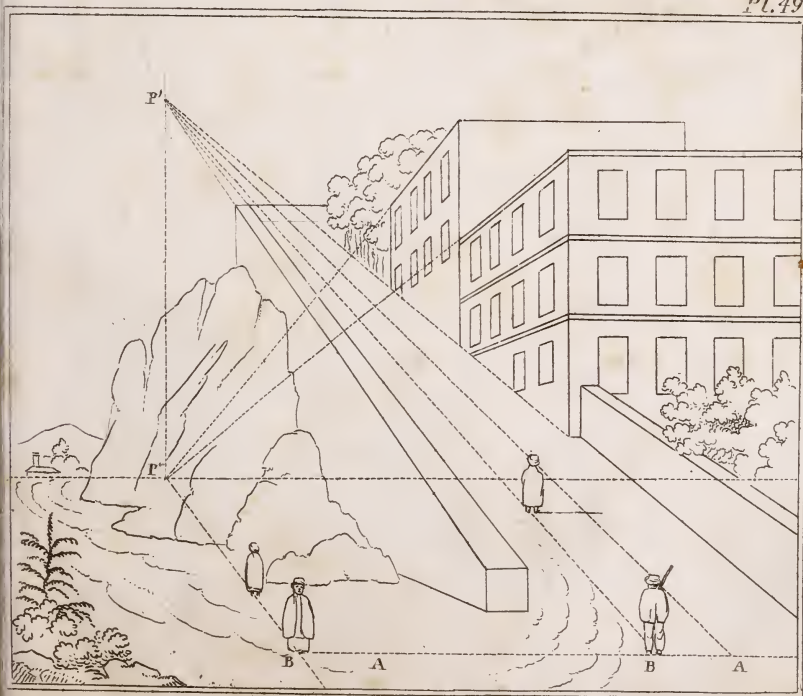
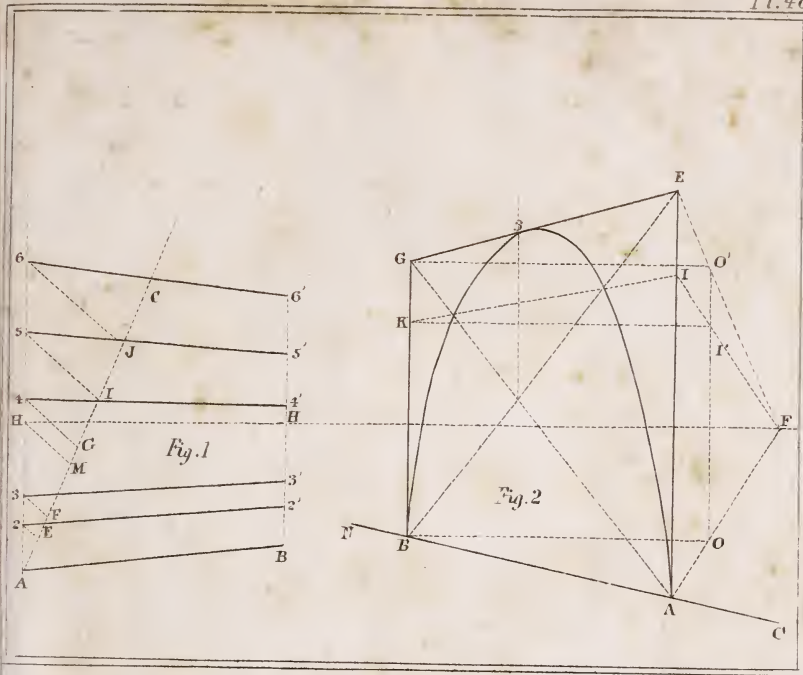






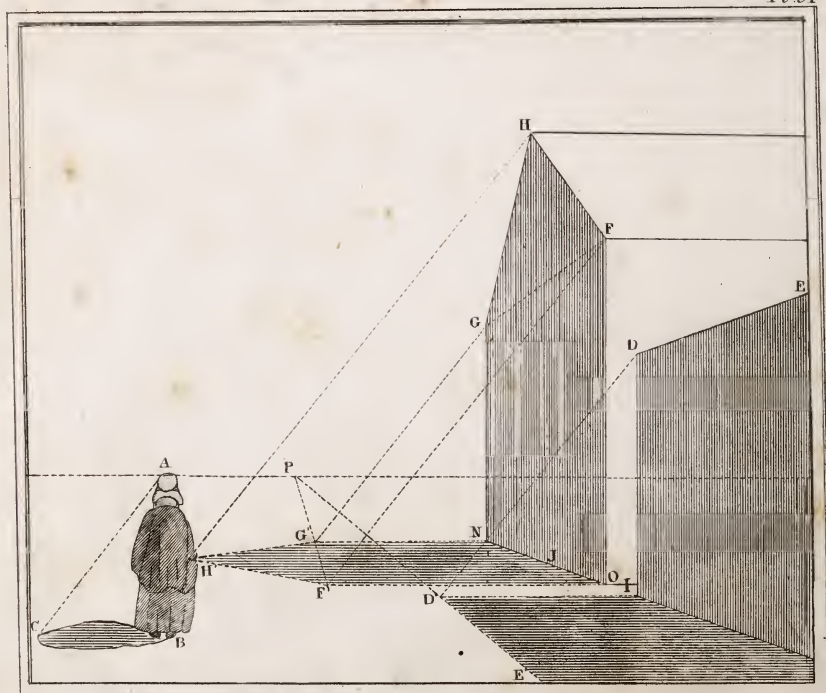


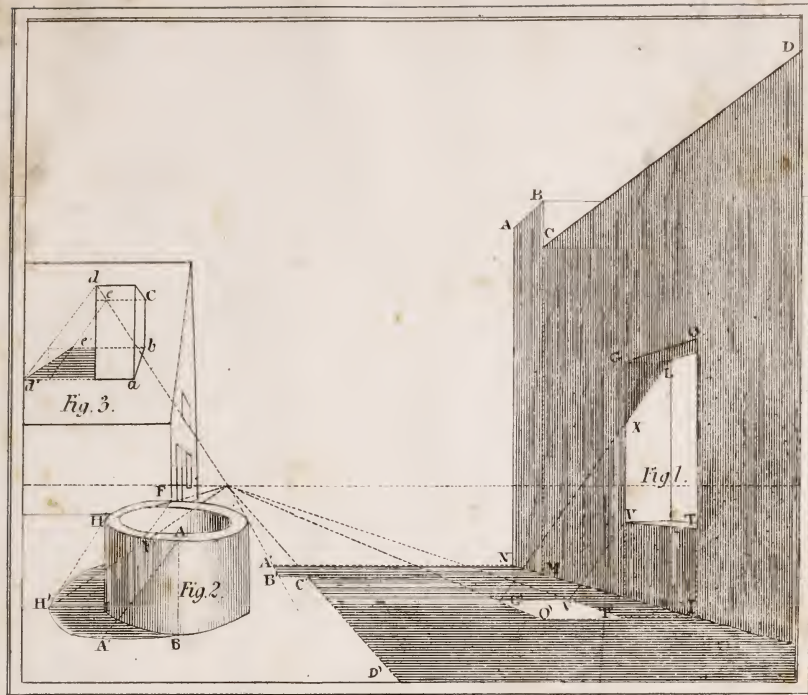






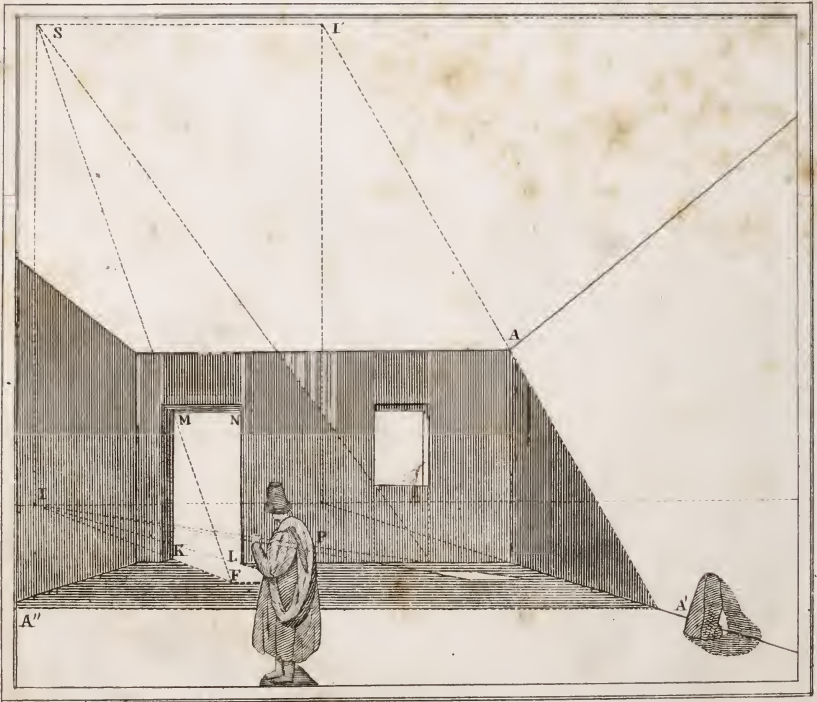
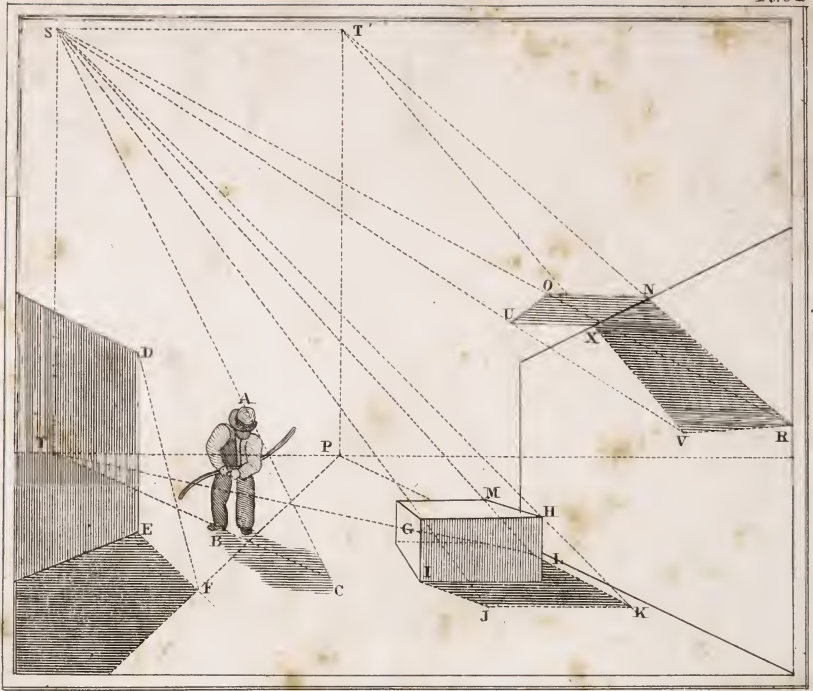


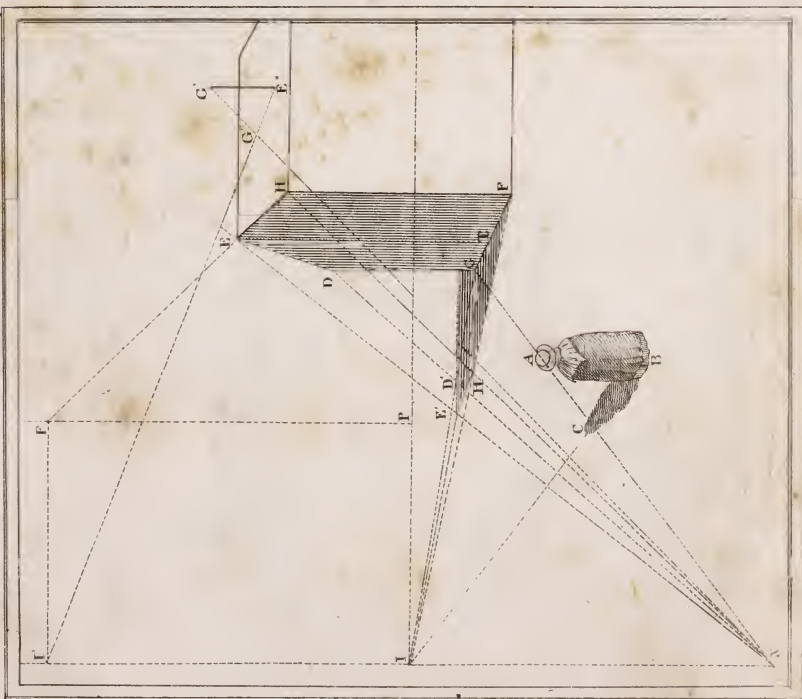
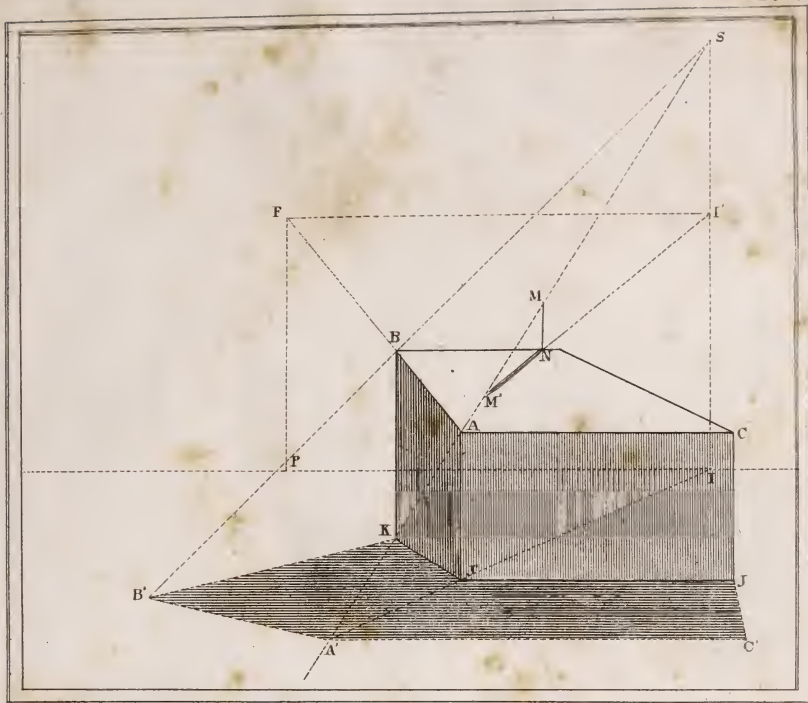






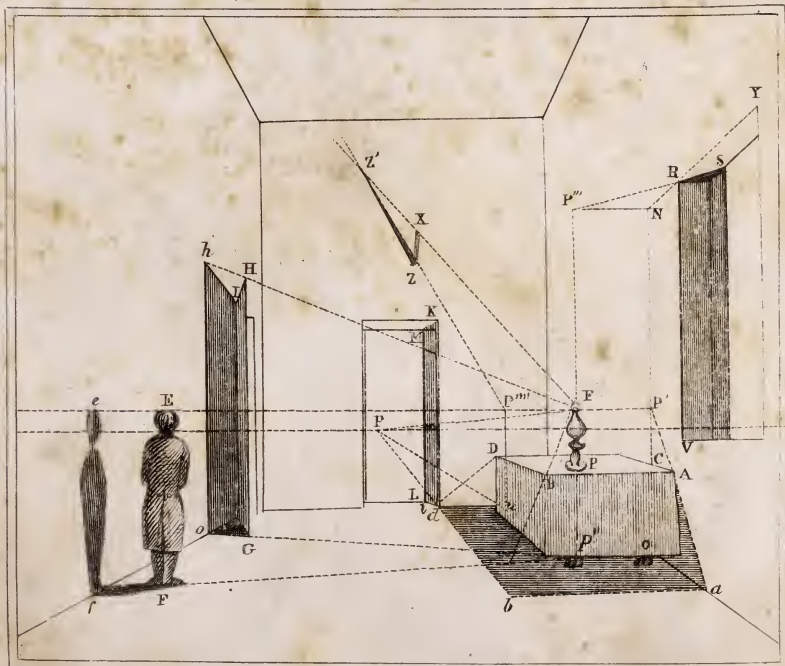
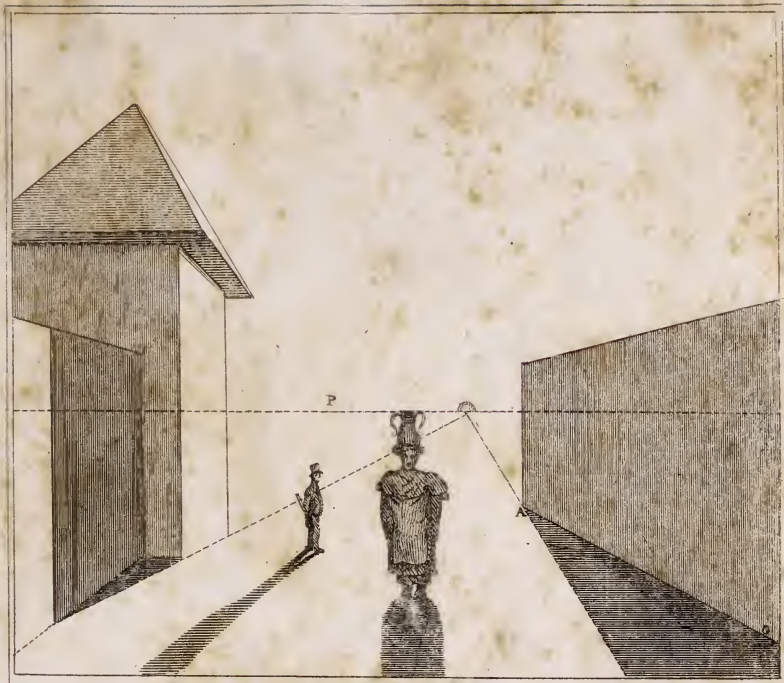






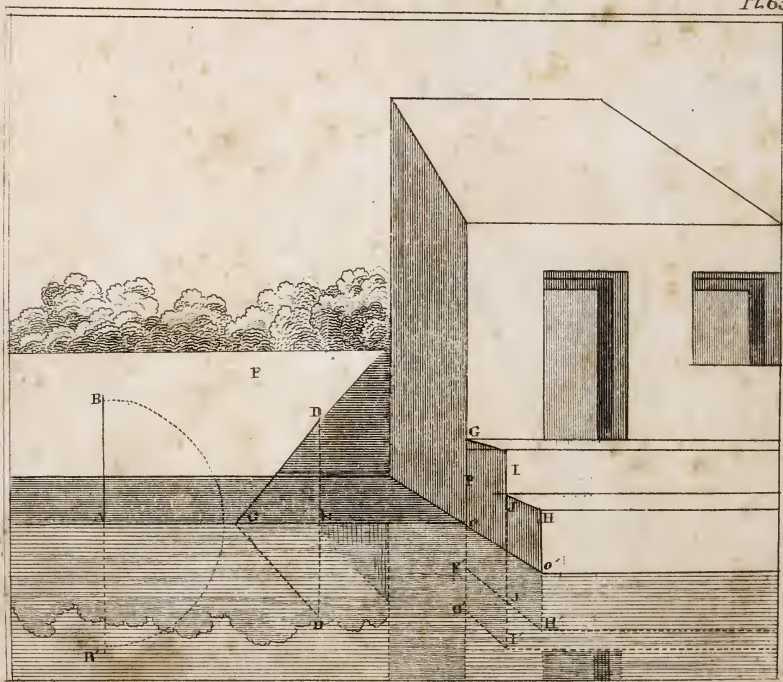
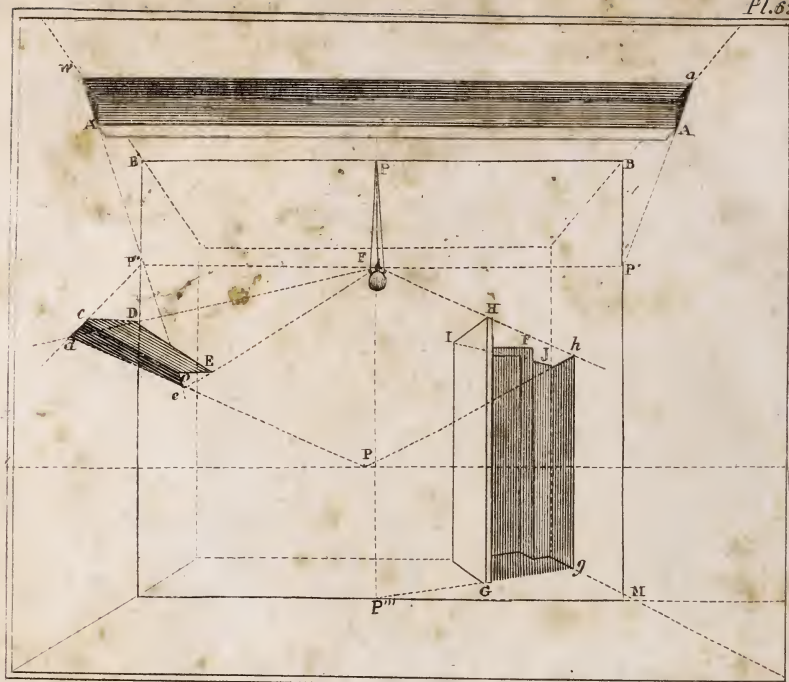


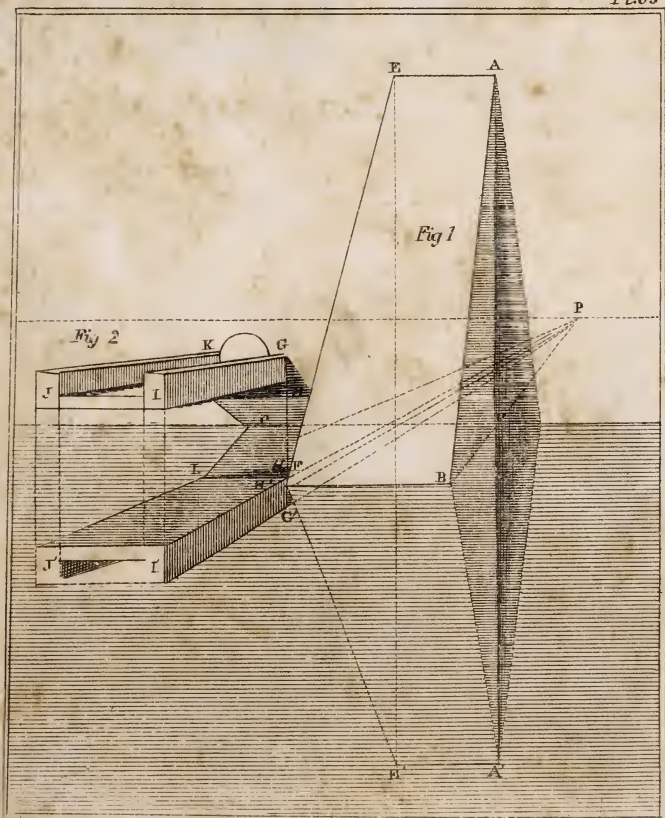
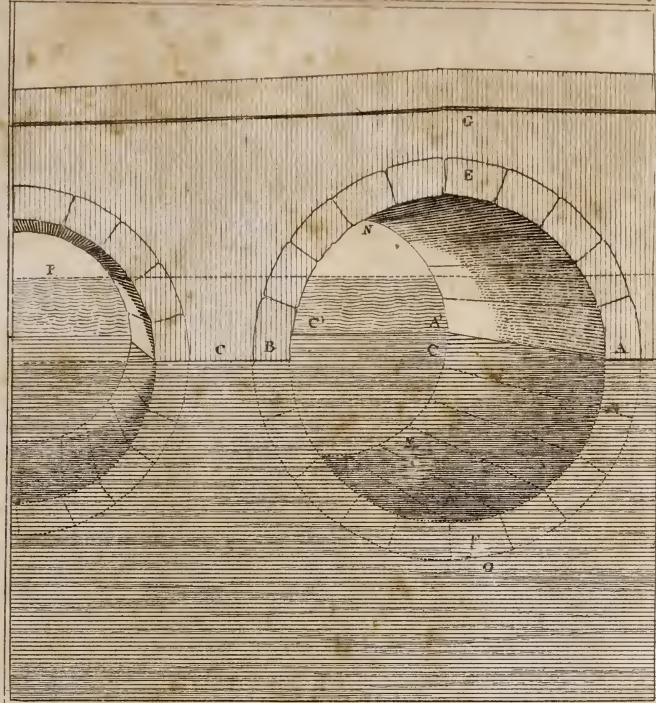




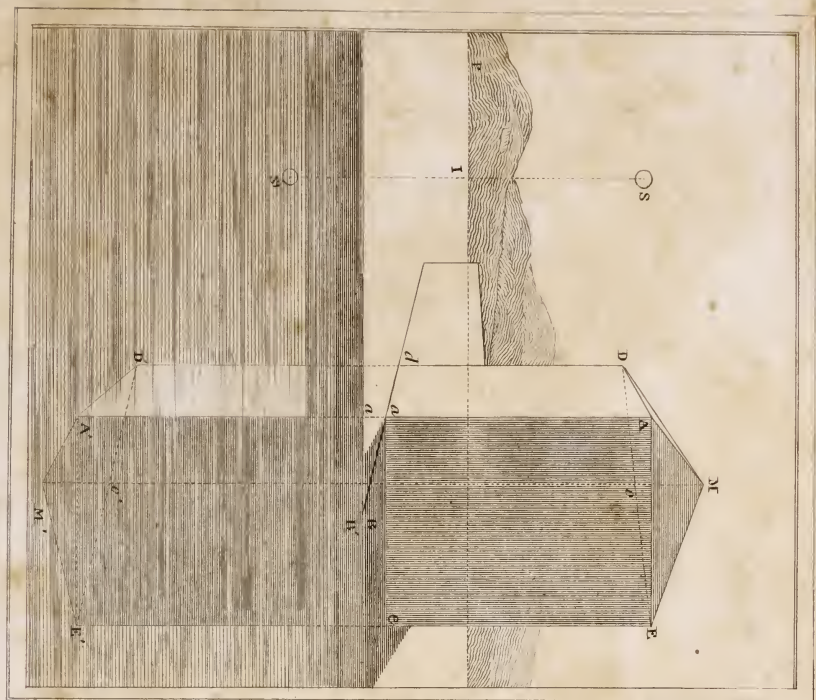












Pl. 66

Pl. 67

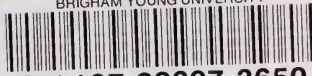




DATE DUE

MAY 14 1992		
FEB 29 1992		
JUN 04 1994		
JUN 27 1994		
JAN 27 1999		
JAN 27 1999		
NOV 16 2005		
OCT 28 2005		

BRIGHAM YOUNG UNIVERSITY



3 1197 20697 3650

